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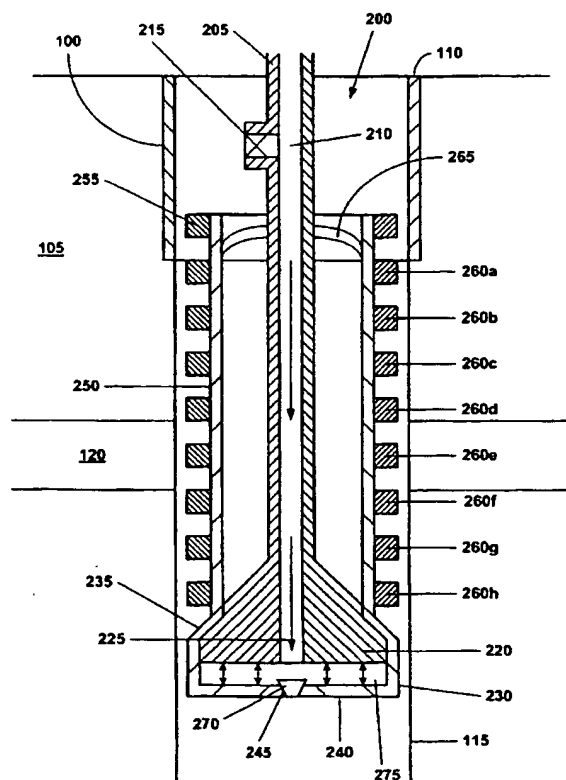
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[Continued on next page]

(54) Title: **LINER HANGER WITH STANDOFFS**



(57) Abstract: An apparatus and method for forming or repairing a wellbore casing (110) by radially expanding a tubular liner (250) having standoffs (260a-h).

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— *with amended claims*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

--- with international search report

LINER HANGER WITH STANDOFFS  
Cross Reference To Related Applications

This application claims the benefit of the filing date of U.S. provisional patent application serial number 60/221,645, attorney docket number 25791.46, filed on 7/28/2000, the disclosure of which is incorporated herein by reference.

This application is related to the following co-pending applications:

(1) U.S. patent application serial no. 09/440,338, attorney docket number 25791.9.02, filed on 11/15/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/108,558, attorney docket number 25791.9, filed on 11/16/1998, (2) U.S. patent application serial no. 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/111,293, filed on 12/7/1998, (3) U.S. patent application serial number 09/502,350, attorney docket number 25791.8.02, filed on 2/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/119,611, attorney docket number 25791.8, filed on 2/11/1999, (4) U.S. patent application serial number 09/510,913, attorney docket number 25791.7.02, filed on 2/23/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,702, attorney docket number 25791.7, filed on 2/25/1999, (5) U.S. patent application serial number 09/511,941, attorney docket number 25791.16.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application number 60/121,907, attorney docket number 25791.16, filed on 2/26/1999, (6) U.S. patent application serial number 09/523,460, attorney docket number 25791.11.02, filed on 3/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/124,042, attorney docket number 25791.11, filed on 3/11/1999, (7) U.S. patent application serial number 09/559,122, attorney docket number 25791.23.02, filed on 4/26/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/131,106,

attorney docket number 25791.23, filed on 4/26/1999, (8) U.S. patent application serial number \_\_\_\_\_, attorney docket number 25791.17.02, filed on \_\_\_\_\_, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/137,998, attorney docket number 25791.17, filed on 6/7/1999, (9) U.S. provisional patent application serial number 60/143,039, attorney docket number 25791.26, filed on 7/9/1999, (10) U.S. provisional patent application serial number 60/146,203, attorney docket number 25791.25, filed on 7/29/1999, the disclosures of which are incorporated by reference; (11) U.S. provisional patent application serial number 60/183,546, attorney docket number 25791.10, filed on 2/18/2000; (12) U.S. patent application serial number 09/512,895, attorney docket number 25791.12.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,841, attorney docket number 25791.12, filed on 2/26/1999; (13) U.S. provisional patent application serial number \_\_\_\_\_, attorney docket number 25791.38, filed on 6/19/2000; (14) U.S. provisional patent application serial number 60/162,671, attorney docket number 25791.27, filed on 11/1/1999; (15) U.S. provisional patent application serial number 60/159,039, attorney docket number 25791.36, filed on 10/12/1999; (16) U.S. provisional patent application serial number 60/159,033, attorney docket number 25791.37, filed on 10/12/1999; (17) U.S. provisional patent application serial number 60/165,228, attorney docket number 25791.39, filed on 11/12/1999; and (18) U.S. provisional patent application number \_\_\_\_\_, attorney docket number 25791.45, filed on \_\_\_\_\_, the disclosures of which are incorporated herein by reference.

#### Background of the Invention

This invention relates generally to wellbore casings, and in particular to wellbore casings that are formed using expandable tubing.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to

prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming wellbores and wellheads.

## Summary of the Invention

According to one aspect of the present invention, a method of forming a casing in a wellbore having a cased section and an open hole section is provided that includes positioning a tubular liner within the wellbore, overlapping the tubular liner and the cased section, centering the tubular liner within the wellbore, and radially expanding the tubular liner into contact with the cased section.

According to another aspect of the present invention, a radially expandable tubular member for repairing an opening in a wellbore casing is provided that includes a tubular member, and one or more standoffs coupled to the exterior surface of the tubular member.

According to another aspect of the present invention, an apparatus for repairing an opening in a wellbore casing is provided that includes a tubular support member including a first passage, an expansion cone coupled to the tubular support member including a second passage  
5 fluidically coupled to the first passage, an expansion cone launcher coupled to the expansion cone including a shoe having an exhaust passage, and an expandable tubular member coupled to the expansion cone launcher including one or more standoffs.

According to another aspect of the present invention, an apparatus  
10 is provided that includes a wellbore including a preexisting casing and an open hole section, and a radially expanded tubular member coupled to the preexisting casing including one or more standoffs.

#### Brief Description of the Drawings

FIG. 1 is a cross-sectional view illustrating a wellbore including a  
15 wellbore casing and an open hole section that traverses a porous subterranean layer.

FIG. 2 is a fragmentary cross-sectional view illustrating the introduction of an apparatus for casing the open hole section of the wellbore of FIG. 1.

20 FIG. 3 is a fragmentary cross-sectional view illustrating the injection of a fluidic material into the apparatus of FIG. 2.

FIG. 4 is a fragmentary cross-sectional view illustrating the placement of a plug into the exhaust passage of the shoe of the apparatus of FIG. 3.

25 FIG. 5 is a fragmentary cross-sectional view illustrating the pressurization of the interior portion of the apparatus below the expansion cone of FIG. 4.

FIG. 6 is a fragmentary cross-sectional view illustrating the completion of the radial expansion of the tubular member of the apparatus  
30 of FIG. 5.

FIG. 7 is a fragmentary cross-sectional view illustrating the removal of the shoe from the apparatus of FIG. 6.

#### Detailed Description of the Illustrative Embodiments

An apparatus and method for casing an open hole section of a wellbore within a subterranean formation is provided. The apparatus and method provides a system for casing an open hole section of a wellbore within a subterranean formation in which a tubular member having a plurality of radially oriented standoffs is radially expanded into contact with the preexisting wellbore casing and the open hole section. The standoffs provided on the exterior surface of the tubular member preferably position the tubular member away from the interior walls of the open hole section during the radial expansion process. In this manner, the tubular member does not adhere to underpressurized sections of the open hole section of the wellbore. In this manner, the process of radial expansion is more reliable.

Referring initially to Fig. 1, a wellbore 100 positioned within a subterranean formation 105 includes a preexisting casing 110 and an open hole section 115 that traverses an porous region 120. When the operating pressure within the wellbore  $P_{\text{BORE}}$  is greater than the operating pressure within the porous region  $P_{\text{PORE}}$ , fluidic materials will flow from the wellbore 100 into the porous region 120. As a result of the flow of fluidic materials from the wellbore 100 into the porous region 120, downhole equipment will tend to adhere to, or at least be drawn toward, the interior surface of the wellbore 100 in the vicinity of the porous region 120. This can have serious and adverse consequences when radially expanding a tubular member in such an operating environment.

Referring to Fig. 2, an apparatus 200 for forming a wellbore casing in the open hole section of the wellbore 100 may then be positioned within the wellbore in an overlapping relationship with the lower portion of the preexisting wellbore casing 110.

The apparatus 200 includes a tubular support member 205 having a longitudinal passage 210 and a transverse passage 215 that is coupled to an expansion cone 220 having a longitudinal passage 225 that is fluidically coupled to the longitudinal passage 210. The expansion cone 220 is at least partially received within an expansion cone launcher 230 that includes a thin-walled annular member 235 and a shoe 240 having an exhaust passage 245. An expandable tubular member 250 extends from the expansion cone launcher 230 that includes a sealing member 255 and a plurality of standoffs 260a-260h affixed to the exterior surface of the expandable tubular member. In a preferred embodiment, the standoffs 260 are fabricated from a resilient material. A sealing cup 265 is attached to the exterior surface of the tubular support member 205 for preventing foreign materials from entering the interior of the expandable tubular member 250.

In a preferred embodiment, the apparatus 200 is provided as disclosed in one or more of the following: (1) U.S. patent application serial no. 09/440,338, attorney docket number 25791.9.02, filed on 11/15/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/108,558, attorney docket number 25791.9, filed on 11/16/1998, (2) U.S. patent application serial no. 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/111,293, filed on 12/7/1998, (3) U.S. patent application serial number 09/502,350, attorney docket number 25791.8.02, filed on 2/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/119,611, attorney docket number 25791.8, filed on 2/11/1999, (4) U.S. patent application serial number 09/510,913, attorney docket number 25791.7.02, filed on 2/23/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,702, attorney docket number 25791.7, filed on 2/25/1999, (5) U.S. patent application serial number 09/511,941, attorney



docket number 25791.16.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application number 60/121,907, attorney docket number 25791.16, filed on 2/26/1999, (6) U.S. patent application serial number 09/523,460, attorney docket number

5 25791.11.02, filed on 3/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/124,042, attorney docket number 25791.11, filed on 3/11/1999, (7) U.S. patent application serial number 09/559,122, attorney docket number

10 25791.23.02, filed on 4/26/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/131,106, attorney docket number 25791.23, filed on 4/26/1999, (8) U.S. patent application serial number \_\_\_\_\_, attorney docket number

15 25791.17.02, filed on \_\_\_\_\_, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/137,998, attorney docket number 25791.17, filed on 6/7/1999, (9) U.S. provisional patent application serial number 60/143,039, attorney docket number

20 25791.26, filed on 7/9/1999, (10) U.S. provisional patent application serial number 60/146,203, attorney docket number 25791.25, filed on 7/29/1999, the disclosures of which are incorporated by reference; (11) U.S. provisional patent application serial number 60/183,546, attorney docket

25 25791.10, filed on 2/18/2000; (12) U.S. patent application serial number 09/512,895, attorney docket number 25791.12.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,841, attorney docket number

30 25791.12, filed on 2/26/1999; (13) U.S. provisional patent application serial number \_\_\_\_\_, attorney docket number 25791.38, filed on 6/19/2000; (14) U.S. provisional patent application serial number 60/162,671, attorney docket number 25791.27, filed on 11/1/1999; (15) U.S. provisional patent application serial number 60/159,039, attorney docket

number 25791.36, filed on 10/12/1999; (16) U.S. provisional patent application serial number 60/159,033, attorney docket number 25791.37,

filed on 10/12/1999; and (17) U.S. provisional patent application serial number 60/165,228, attorney docket number 25791.39, filed on 11/12/1999, the disclosures of which are incorporated herein by reference.

As illustrated in Fig. 2, during placement of the apparatus 200 within the wellbore 100, fluidic materials displaced by the apparatus 200 are conveyed through the longitudinal passages 210 and 225 to the transverse passage 215. In this manner, surge pressures during the placement of the apparatus 200 within the wellbore 100 are minimized. Furthermore, as illustrated in Fig. 2, the apparatus 200 is preferably initially positioned with upper portion of the tubular member 250 in opposing relation to the lower portion of the preexisting wellbore casing 110. In this manner, the upper portion of the tubular member 250 may be radially expanded into contact with the lower portion of the preexisting wellbore casing 110. In a preferred embodiment, during the placement of the apparatus 200 within the wellbore 100, the standoffs 260a-260h prevent the apparatus 200 from adhering to, or being drawn toward, the interior surface of the wellbore 100 in the vicinity of the porous region 120. In this manner, the apparatus 200 is approximately centered within the wellbore 100.

As illustrated in Fig. 3, the transverse passage 215 may then be closed and fluidic materials injected into the apparatus 200 through the longitudinal passage 210. In this manner, any blockages within any of the passages 210, 225, and 245 may be detected by monitoring the operating pressure whereby an increase in operating pressure above nominal, or predetermined, conditions may indicate a blockage of one of the passages.

As illustrated in Fig. 4, a plug 270 or other conventional stop member may then be introduced into the fluidic materials injected into the apparatus 200 through the passage 210, and the plug 270 may be positioned within the exhaust passage 245. In this manner, the exhaust passage 245 may be sealed off. Thus, continued injection of fluidic

materials into the apparatus 200 through the passage 210 may thereby pressurize a region 275 below the expansion cone 220.

As illustrated in Figs. 5 and 6, continued pressurization of the region 275 causes the expansion cone 220 to radially expand the expandable tubular member 250 off of the expansion cone. In this manner, the upper portion of the radially expanded tubular member 250 is coupled to the lower portion of the preexisting wellbore casing 110. In a preferred embodiment, during the radial expansion process, the tubular support member 205 is raised out of the wellbore 100.

In a preferred embodiment, throughout the radial expansion process, the standoffs 260a-260h prevent the exterior surface of the apparatus 200 from adhering to, or being drawn toward, the interior surface of the wellbore 100 in the vicinity of the porous region 120. In this manner, the apparatus 200 is preferably substantially centered within the wellbore 100. Furthermore, in this manner, the longitudinal center axis of the expansion cone 220 is preferably maintained in a position that is substantially coincident with the longitudinal center axis of the tubular member 250. In addition, in this manner, the stresses applied to the interior surface of the tubular member 250 by the axial displacement of the expansion cone 220 are substantially even. Finally, in this manner, overstressing of the tubular member 250 is prevented thereby eliminating catastrophic failure of the tubular member 250.

As illustrated in Fig. 7, the shoe 240 may then be removed using a conventional milling device.

In a preferred embodiment, upon radially expanding the expandable tubular member 250, the standoffs 260a-260h seal and isolate intervals within the open hole section 115. In several alternative embodiments, the standoffs 260 may be provided, for example, by annular members spaced along the length of the expandable tubular member 250 and/or a continuous member that is wrapped around the expandable tubular member 250 in helical fashion.

It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the apparatus 200 may be used to form and/or repair, for example, a wellbore casing, a pipeline, or a structural support.

5           Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is  
10       appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

## Claims

What is claimed is:

- 1     1.     A method of forming a casing in a wellbore having a cased section  
2     and an open hole section, comprising:  
3         positioning a tubular liner within the wellbore;  
4         overlapping the tubular liner and the cased section;  
5         centering the tubular liner within the wellbore; and  
6         radially expanding the tubular liner into contact with the cased  
7         section.
- 8     2.     The method of claim 1, wherein centering comprises:  
9         preventing the tubular liner from adhering to the open hole section  
10         of the wellbore.
- 1     3.     A radially expandable tubular member for repairing an opening in  
2     a wellbore casing, comprising:  
3         a tubular member; and  
4         one or more standoffs coupled to the exterior surface of the tubular  
5         member.
- 1     4.     An apparatus for repairing an opening in a wellbore casing,  
2     comprising:  
3         a tubular support member comprising a first passage;  
4         an expansion cone coupled to the tubular support member  
5             comprising a second passage fluidically coupled to the first  
6             passage;  
7         an expansion cone launcher coupled to the expansion cone  
8             comprising a shoe having an exhaust passage; and  
9         an expandable tubular member coupled to the expansion cone  
10         launcher comprising one or more standoffs.

1     5.     An apparatus, comprising:  
2             a wellbore comprising a preexisting casing and an open hole section;  
3             and  
4             a radially expanded tubular member coupled to the preexisting  
5             casing comprising one or more standoffs.

1     6.     A system for forming a casing in a wellbore having a cased section  
2     and an open hole section, comprising:  
3             means for positioning a tubular liner within the wellbore;  
4             means for overlapping the tubular liner and the cased section;  
5             means for centering the tubular liner within the wellbore; and  
6             means for radially expanding the tubular liner into contact with the  
7             cased section.

1     7.     The system of claim 6, wherein the means for centering comprises:  
2             means for preventing the tubular liner from adhering to the open  
3             hole section of the wellbore.

**AMENDED CLAIMS**

[received by the International Bureau on 16 January 2002 (16.01.02);  
original claims 1-7 cancelled; claims 8-19 added (7 pages)]

1     5.     [DELETED]

1     6.     [DELETED]

1     7.     [DELETED]

1     8.     In a wellbore that traverses a subterranean formation and includes a cased  
2     section having a wellbore casing and an uncased section that traverses a porous  
3     subterranean zone, wherein the operating pressure of the wellbore is greater than  
4     the operating pressure of the porous subterranean zone, a method of coupling a  
5     tubular liner to the wellbore casing of the cased section of the wellbore,  
6     comprising:

7             positioning a solid tubular liner and an expansion cone within the wellbore  
8             with the solid tubular liner overlapping the wellbore casing;  
9             during the positioning of the solid tubular liner within the wellbore,  
10            preventing the portion of the solid tubular liner that does not  
11            overlap with the wellbore casing from contacting the porous  
12            subterranean zone of the uncased section of the wellbore;  
13            radially expanding the solid tubular liner by injecting a fluidic material  
14            into the tubular liner to pressurize the interior of the solid tubular  
15            liner and displace the expansion cone relative to the solid tubular  
16            liner; and  
17            preventing the portion of the solid tubular liner that does not overlap with  
18            the wellbore casing from contacting the porous subterranean zone  
19            of the uncased section of the wellbore during the radial expansion of  
20            the portion of the solid tubular liner that does not overlap with the  
21            wellbore casing.

1     9.     The method of claim 8, further comprising:  
2             during the positioning of the solid tubular liner within the wellbore,  
3             preventing the portion of the solid tubular liner that does not  
4             overlap with the wellbore casing from adhering to the porous  
5             subterranean zone of the uncased section of the wellbore; and

6 preventing the portion of the solid tubular liner that does not overlap with  
7 the wellbore casing from adhering to the porous subterranean zone  
8 of the uncased section of the wellbore during the radial expansion of  
9 the portion of the solid tubular liner that does not overlap with the  
10 wellbore casing.

1 10. In a wellbore that traverses a subterranean formation, the wellbore  
2 including a cased section having a wellbore casing and an uncased section, a  
3 method of coupling a tubular liner to the wellbore casing of the cased section of  
4 the wellbore, comprising:  
5 positioning a solid tubular liner and an expansion cone within the wellbore  
6 with the solid tubular liner overlapping the wellbore casing;  
7 during the positioning of the portion of the solid tubular liner that does not  
8 overlap with the wellbore casing within the wellbore, maintaining  
9 the longitudinal center line of the expansion cone in a position that  
10 is substantially coincident with the longitudinal center line of the  
11 portion of the solid tubular liner that does not overlap with the  
12 wellbore casing;  
13 radially expanding the solid tubular liner by injecting a fluidic material  
14 into the tubular liner to pressurize the interior of the solid tubular  
15 liner and displace the expansion cone relative to the solid tubular  
16 liner; and  
17 maintaining the longitudinal center line of the expansion cone in a position  
18 that is substantially coincident with the longitudinal center line of  
19 the portion of the solid tubular liner that does not overlap with the  
20 wellbore casing during the radial expansion of the portion of the  
21 solid tubular liner that does not overlap with the wellbore casing.

1 11. In a wellbore that traverses a subterranean formation, the wellbore  
2 including a cased section having a wellbore casing and an uncased section, a  
3 method of coupling a tubular liner to the wellbore casing of the cased section of  
4 the wellbore, comprising:  
5 positioning a solid tubular liner and an expansion cone within the wellbore;  
6 overlapping a portion of the solid tubular liner with the wellbore casing;



7 radially expanding the solid tubular liner by injecting a fluidic material  
8 into the tubular liner to pressurize the interior of the solid tubular  
9 liner and displace the expansion cone relative to the solid tubular  
10 liner; and  
11 during the radial expansion of the portion of the solid tubular liner that  
12 does not overlap with the wellbore casing, applying substantially  
13 equal stresses to the interior surface of the portion of the solid  
14 tubular liner that does not overlap with the wellbore casing using  
15 the expansion cone.

1 12. In a wellbore that traverses a subterranean formation and includes a cased  
2 section having a wellbore casing and an uncased section that traverses a porous  
3 subterranean zone, wherein the operating pressure of the wellbore is greater than  
4 the operating pressure of the porous subterranean zone, a system for coupling a  
5 tubular liner to the wellbore casing of the cased section of the wellbore,  
6 comprising:  
7 means for positioning a solid tubular liner and an expansion cone within  
8 the wellbore with the solid tubular liner overlapping the wellbore  
9 casing;  
10 means for during the positioning of the solid tubular liner within the  
11 wellbore, preventing the portion of the solid tubular liner that does  
12 not overlap with the wellbore casing from contacting the porous  
13 subterranean zone of the uncased section of the wellbore;  
14 means for radially expanding the solid tubular liner by injecting a fluidic  
15 material into the tubular liner to pressurize the interior of the solid  
16 tubular liner and displace the expansion cone relative to the solid  
17 tubular liner; and  
18 means for preventing the portion of the solid tubular liner that does not  
19 overlap with the wellbore casing from contacting the porous  
20 subterranean zone of the uncased section of the wellbore during the  
21 radial expansion of the portion of the solid tubular liner that does  
22 not overlap with the wellbore casing.

1     13.   The system of claim 12, further comprising:  
2           means for during the positioning of the solid tubular liner within the  
3                 wellbore, preventing the portion of the solid tubular liner that does  
4                 not overlap with the wellbore casing from adhering to the porous  
5                 subterranean zone of the uncased section of the wellbore; and  
6           means for preventing the portion of the solid tubular liner that does not  
7                 overlap with the wellbore casing from adhering to the porous  
8                 subterranean zone of the uncased section of the wellbore during the  
9                 radial expansion of the portion of the solid tubular liner that does  
10                not overlap with the wellbore casing.

1     14.   In a wellbore that traverses a subterranean formation, the wellbore  
2     including a cased section having a wellbore casing and an uncased section, a  
3     system for coupling a tubular liner to the wellbore casing of the cased section of  
4     the wellbore, comprising:  
5           means for positioning a solid tubular liner and an expansion cone within  
6                 the wellbore with the solid tubular liner overlapping the wellbore  
7                 casing;  
8           means for during the positioning of the portion of the solid tubular liner  
9                 that does not overlap with the wellbore casing within the wellbore,  
10                maintaining the longitudinal center line of the expansion cone in a  
11                position that is substantially coincident with the longitudinal center  
12                line of the portion of the solid tubular liner that does not overlap  
13                with the wellbore casing;  
14          means for radially expanding the solid tubular liner by injecting a fluidic  
15                material into the tubular liner to pressurize the interior of the solid  
16                tubular liner and displace the expansion cone relative to the solid  
17                tubular liner; and  
18          means for maintaining the longitudinal center line of the expansion cone in  
19                a position that is substantially coincident with the longitudinal  
20                center line of the portion of the solid tubular liner that does not  
21                overlap with the wellbore casing during the radial expansion of the  
22                portion of the solid tubular liner that does not overlap with the  
23                wellbore casing.

- 1     15.     In a wellbore that traverses a subterranean formation, the wellbore  
2     including a cased section having a wellbore casing and an uncased section, a  
3     system for coupling a tubular liner to the wellbore casing of the cased section of  
4     the wellbore, comprising:  
5         positioning a solid tubular liner and an expansion cone within the wellbore;  
6         overlapping a portion of the solid tubular liner with the wellbore casing;  
7         radially expanding the solid tubular liner by injecting a fluidic material  
8             into the tubular liner to pressurize the interior of the solid tubular  
9             liner and displace the expansion cone relative to the solid tubular  
10            liner; and  
11         during the radial expansion of the portion of the solid tubular liner that  
12             does not overlap with the wellbore casing, applying substantially  
13             equal stresses to the interior surface of the portion of the solid  
14             tubular liner that does not overlap with the wellbore casing using  
15             the expansion cone.
- 1     16.     An apparatus for coupling a tubular liner to a wellbore casing within a  
2     wellbore that traverses a porous subterranean formation, comprising:  
3         a tubular support member defining a first internal passage;  
4         an expansion cone coupled to the tubular support member defining a  
5             second internal passage fluidically coupled to the first internal  
6             passage;  
7         a tubular expansion cone launcher movably coupled to and mating with the  
8             expansion cone;  
9         a solid tubular liner coupled to an end of the tubular expansion cone  
10            launcher; and  
11         a shoe coupled to another end of the tubular expansion cone launcher  
12             including a valveable passage;  
13         means for during a positioning of the solid tubular liner within the  
14             wellbore, preventing a portion of the solid tubular liner that does  
15             not overlap with the wellbore casing from contacting the porous  
16             subterranean zone of the wellbore; and

17 means for preventing the portion of the solid tubular liner that does not  
18 overlap with the wellbore casing from contacting the porous  
19 subterranean zone of the wellbore during a radial expansion of the  
20 portion of the solid tubular liner that does not overlap with the  
21 wellbore casing.

1 17. The apparatus of claim 16, further comprising:  
2 means for during the positioning of the solid tubular liner within the  
3 wellbore, preventing the portion of the solid tubular liner that does  
4 not overlap with the wellbore casing from adhering to the porous  
5 subterranean zone of the wellbore; and  
6 means for preventing the portion of the solid tubular liner that does not  
7 overlap with the wellbore casing from adhering to the porous  
8 subterranean zone of the wellbore during the radial expansion of  
9 the portion of the solid tubular liner that does not overlap with the  
10 wellbore casing.

1 18. An apparatus for coupling a tubular liner to a wellbore casing within a  
2 wellbore, comprising:  
3 a tubular support member defining a first internal passage;  
4 an expansion cone coupled to the tubular support member defining a  
5 second internal passage fluidically coupled to the first internal  
6 passage;  
7 a tubular expansion cone launcher movably coupled to and mating with the  
8 expansion cone;  
9 a tubular liner coupled to an end of the tubular expansion cone launcher;  
10 and  
11 a shoe coupled to another end of the tubular expansion cone launcher  
12 including a valveable passage; and  
13 means for during a positioning of a portion of the solid tubular liner that  
14 does not overlap with the wellbore casing within the wellbore,  
15 maintaining a longitudinal center line of the expansion cone in a  
16 position that is substantially coincident with a longitudinal center

17 line of the portion of the solid tubular liner that does not overlap  
18 with the wellbore casing;  
19 means for maintaining the longitudinal center line of the expansion cone in  
20 a position that is substantially coincident with the longitudinal  
21 center line of the solid tubular liner during a longitudinal  
22 displacement of the expansion cone relate to the tubular liner.

1 19. An apparatus for coupling a tubular liner to a wellbore casing within a  
2 wellbore, comprising:  
3 a tubular support member defining a first internal passage;  
4 an expansion cone coupled to the tubular support member defining a  
5 second internal passage fluidicly coupled to the first internal  
6 passage;  
7 a tubular expansion cone launcher movably coupled to and mating with the  
8 expansion cone;  
9 a tubular liner coupled to an end of the tubular expansion cone launcher;  
10 and  
11 a shoe coupled to another end of the tubular expansion cone launcher  
12 including a valveable passage; and  
13 means for during a radial expansion of a portion of the solid tubular liner  
14 that does not overlap with the wellbore casing, applying  
15 substantially equal stresses to the interior surface of the portion of  
16 the solid tubular liner that does not overlap with the wellbore  
17 casing using the expansion cone.

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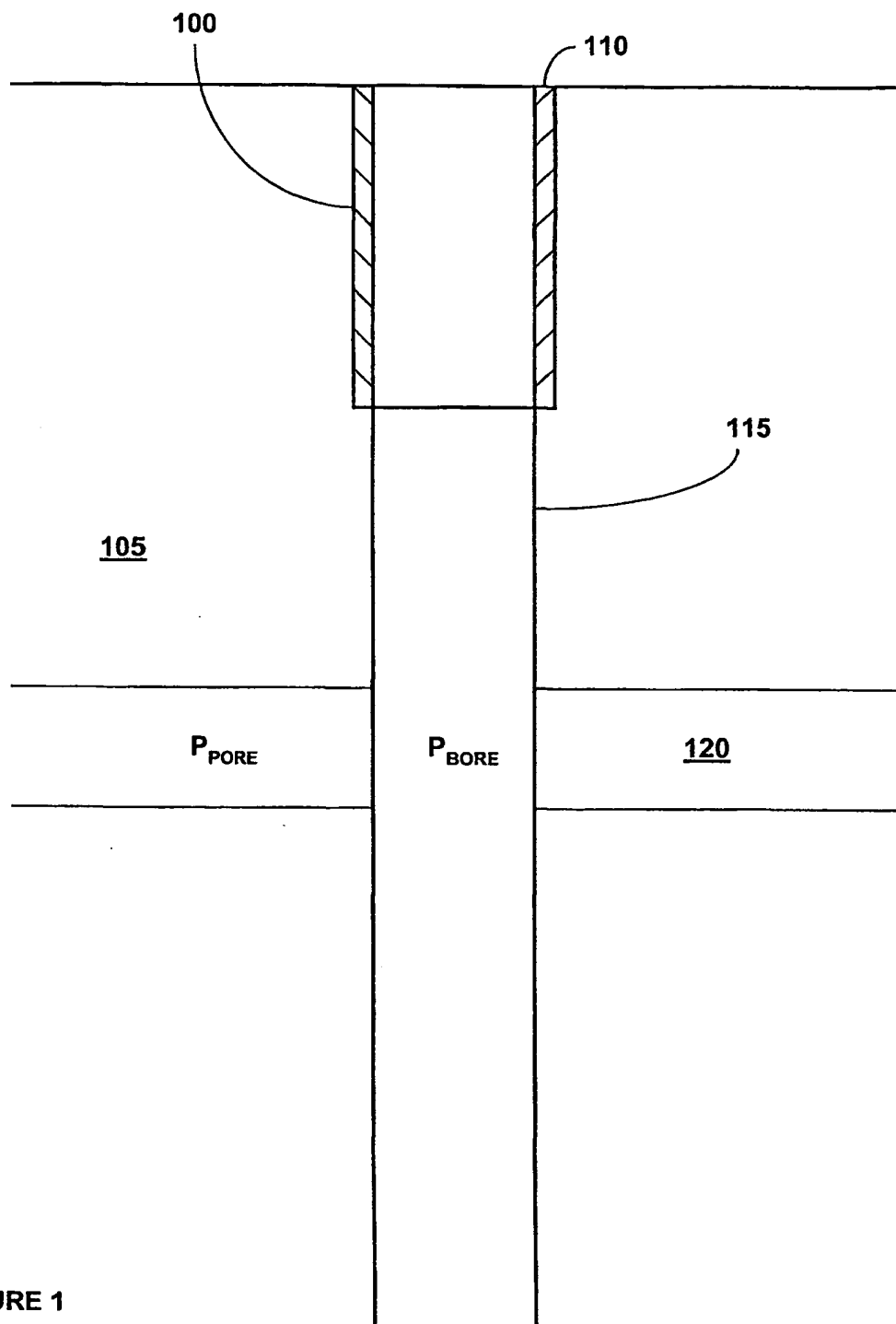


FIGURE 1

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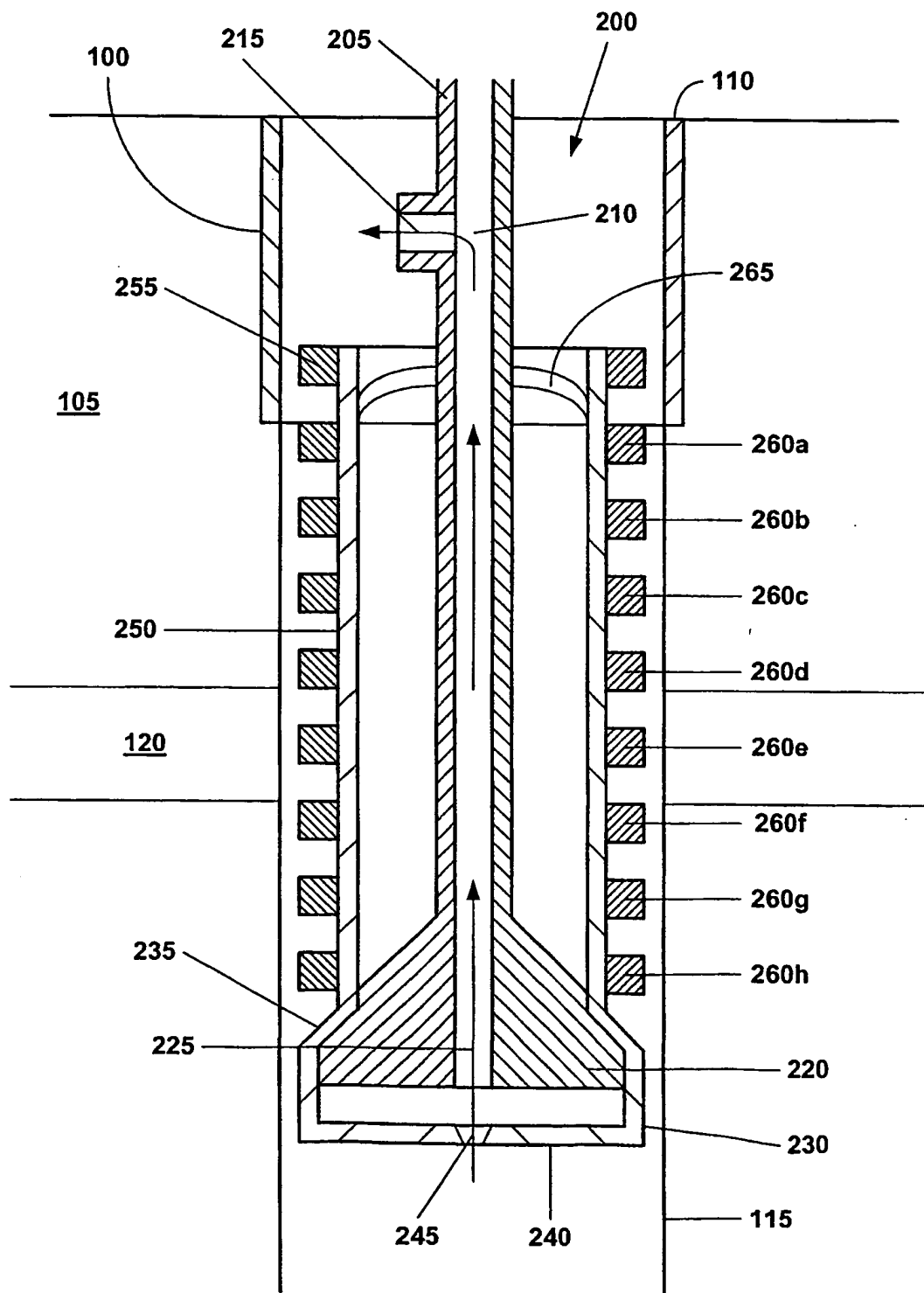
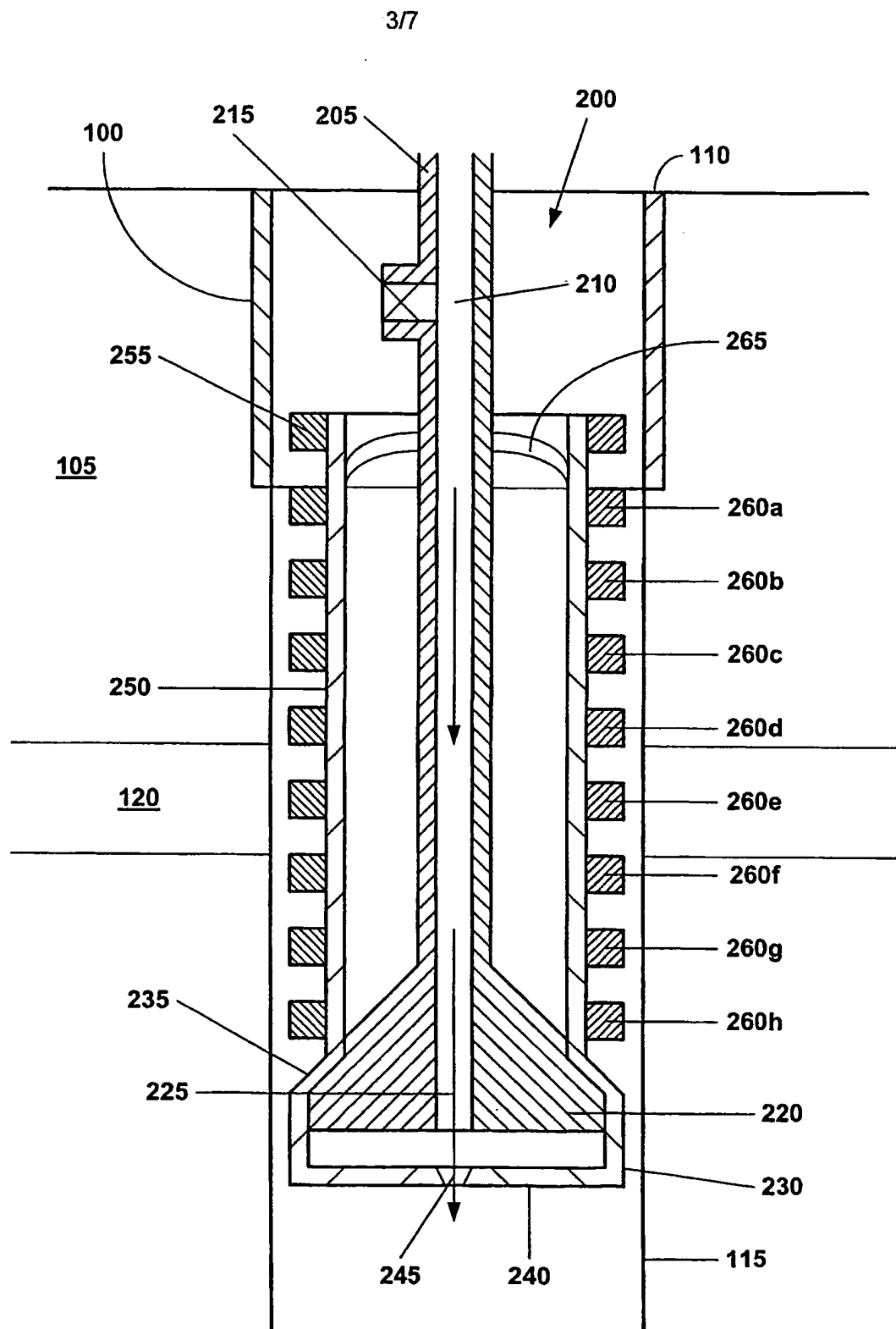


FIGURE 2



**FIGURE 3**



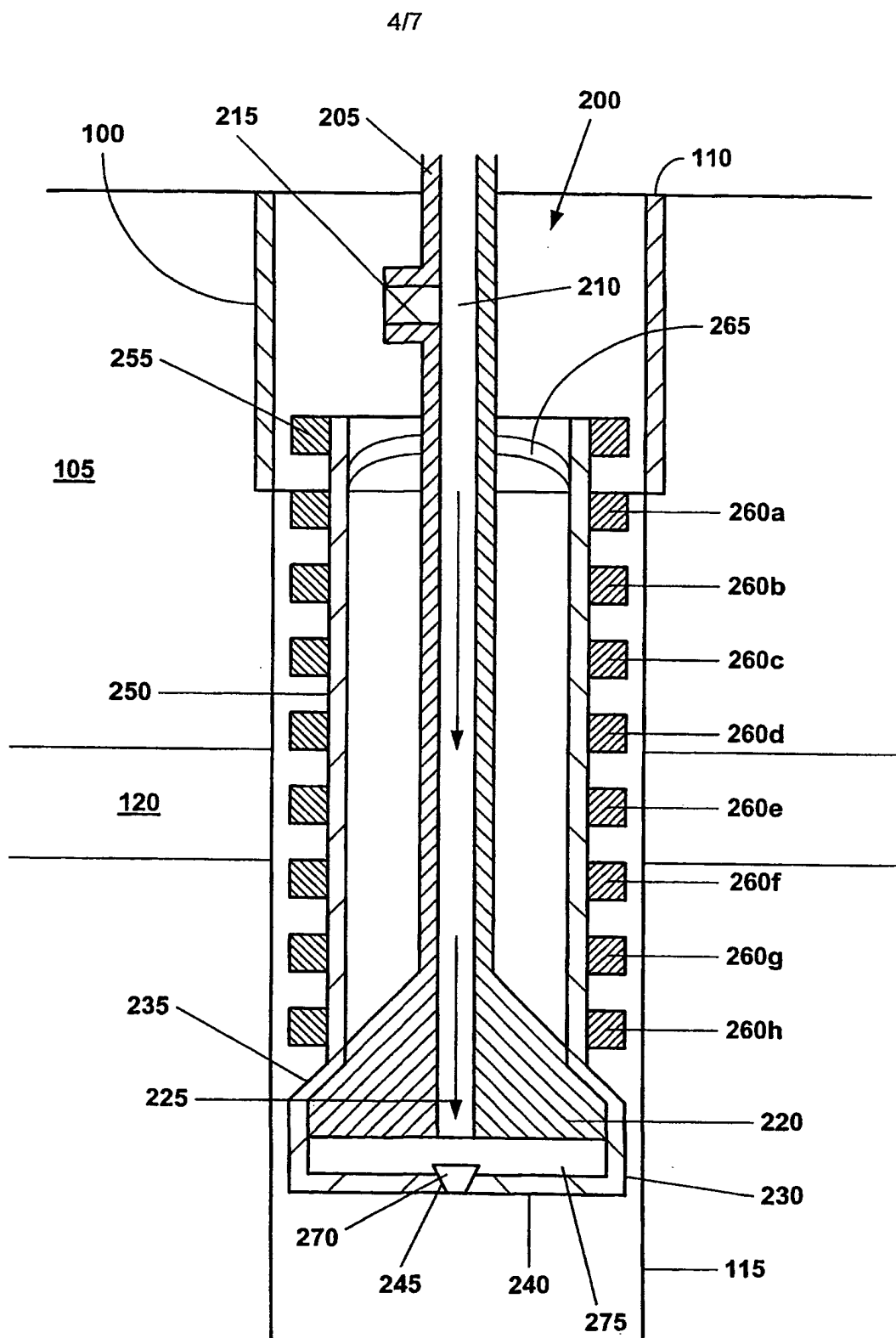


FIGURE 4

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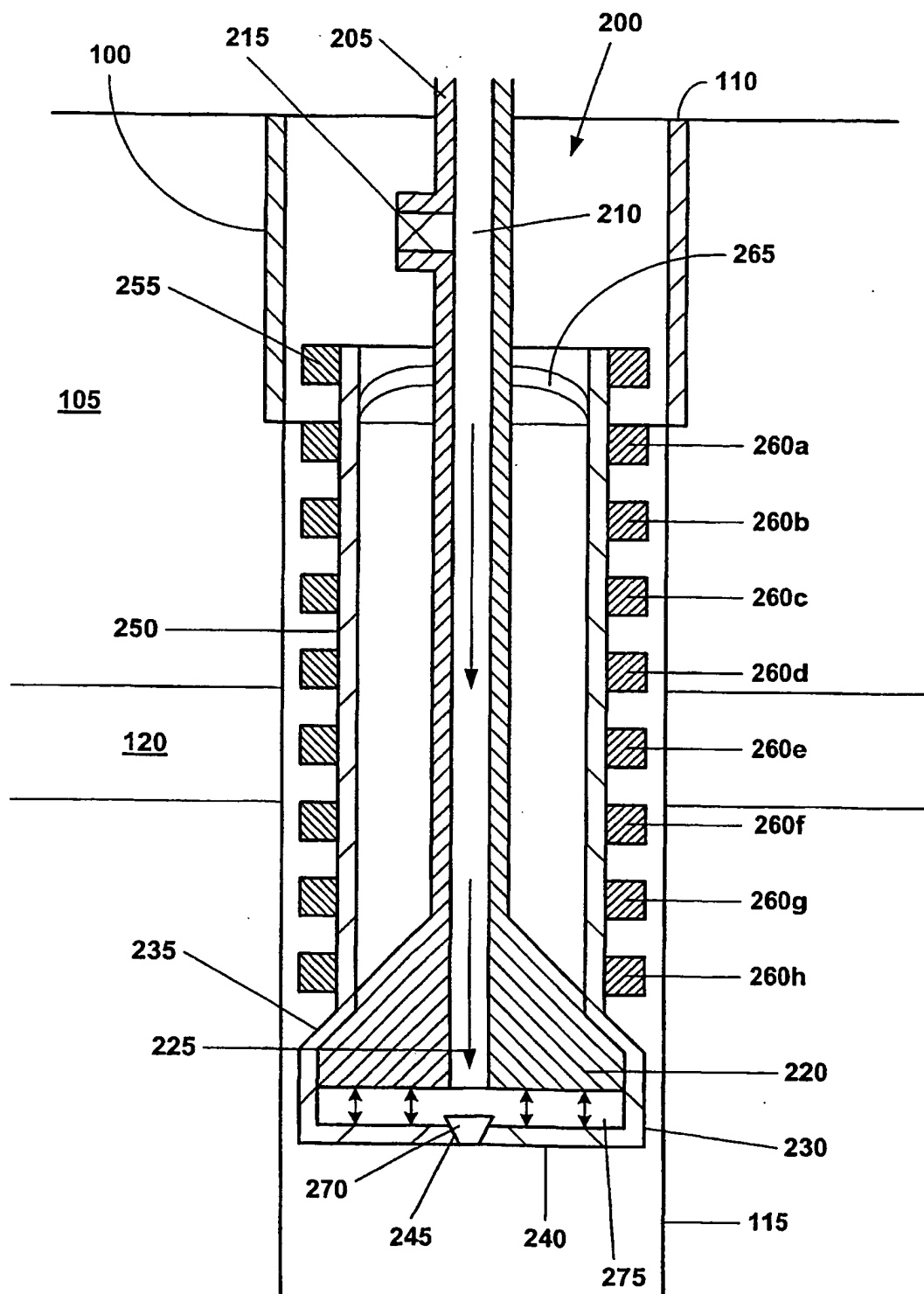


FIGURE 5

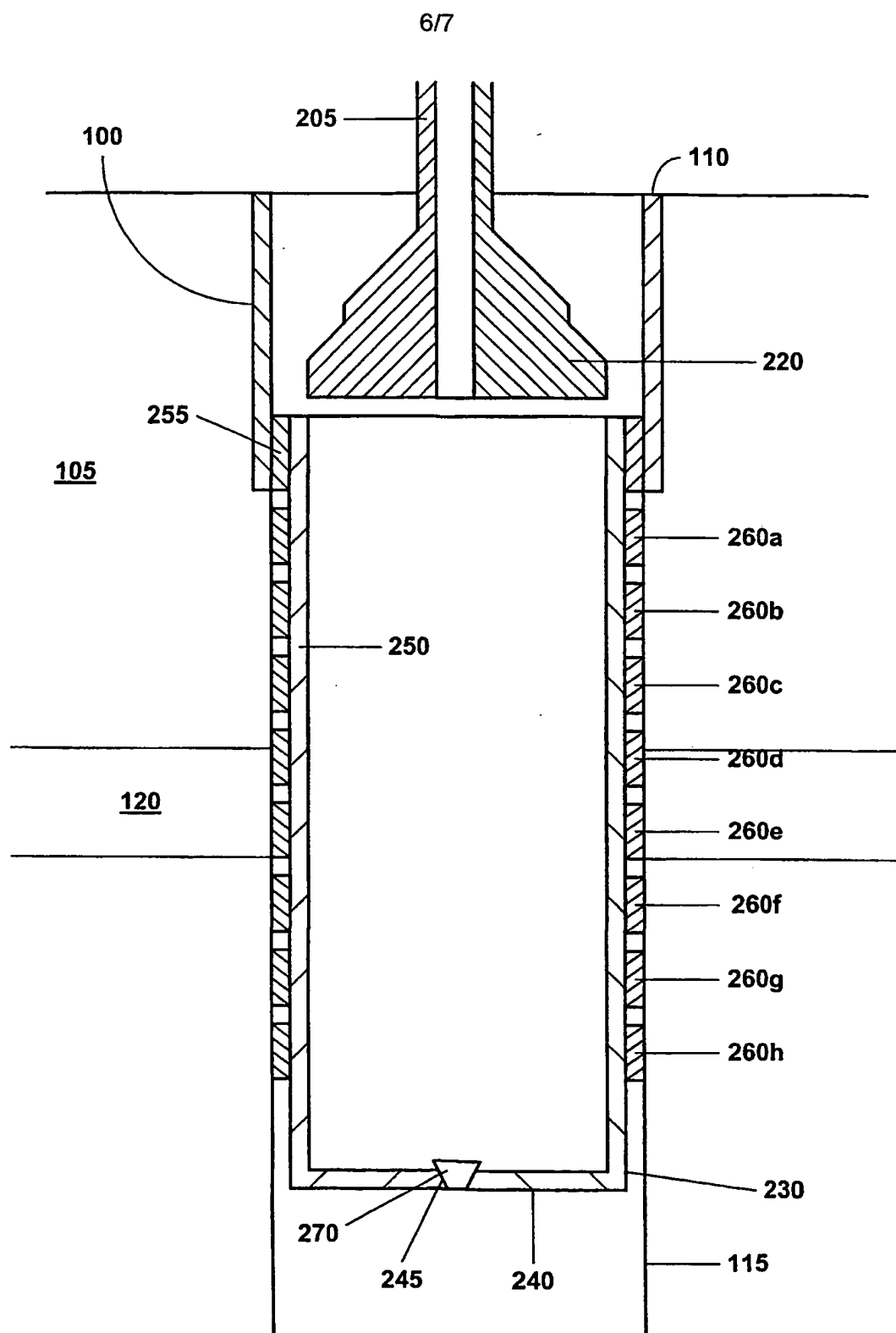


FIGURE 6

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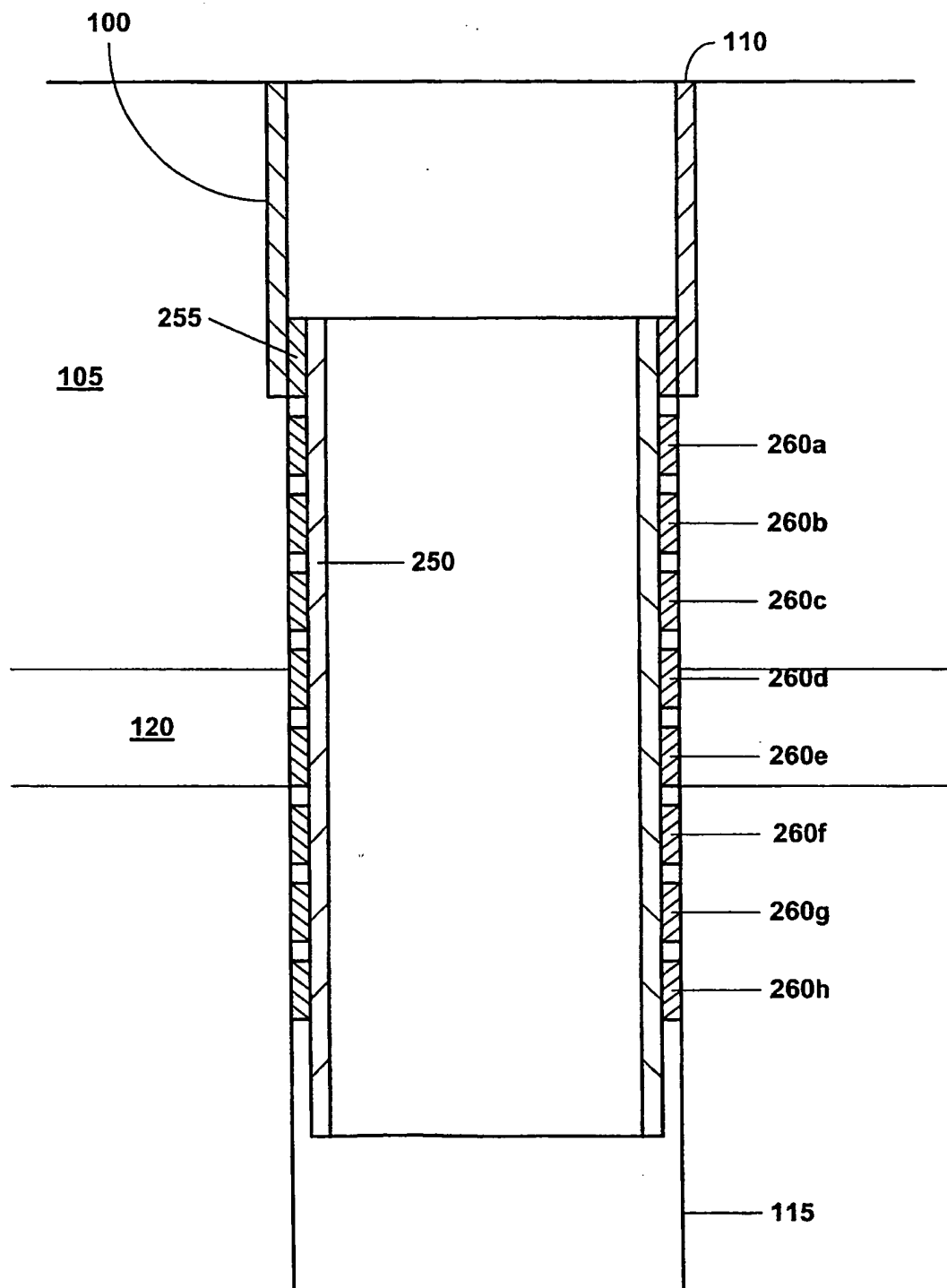


FIGURE 7

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/23815

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : E 21 B 23/00, 23/08, 29/00

US CL : 166/ 207, 277, 383

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 166/ 207, 277, 381, 383

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
Please See Continuation Sheet**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,085,838 A (Versamer et al.) 11 July 2000 (11.07.2000), Figures 2, 5-7, column 4, line 59-61, column 7, lines 6-65.	1-7
X	US 3,353,599 A (Swift) 21 November 1967 (21.11.1967), Figures 3-5, column 3, line 63 - column 4, line 5, column 4, lines 21-45, column 5, lines 11-31.	1, 2
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Y		3,5-7
Y	US 5,494,106 A (Gueguen et al.) 27 February 1996 (27.02.1996), Figure 5, 6, 6A, column 2, lines 53-54, column 4, lines 40-54.	3, 5-7
A	US 2,812,025 A (Teague et al.) 05 November 1957 (05.11.1957), whole document.	
A	US 2,796,134 A (Binkley) 18 June 1957 (18.06.1957), whole document	
A	US 6,012,522 A (Donnelly et al.) 11 January 2000 (11.01.2000), whole document	

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

Special categories of cited documents:	
* "A" document defining the general state of the art which is not considered to be of particular relevance	* "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
* "E" earlier application or patent published on or after the international filing date	* "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
* "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	* "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
* "O" document referring to an oral disclosure, use, exhibition or other means	* "A" document member of the same patent family
* "P" document published prior to the international filing date but later than the priority date claimed	

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/23815

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wellbore, well-bore, expand, expandable, tubular, screen, ridge, ring, seal, standoff, clasp, piston

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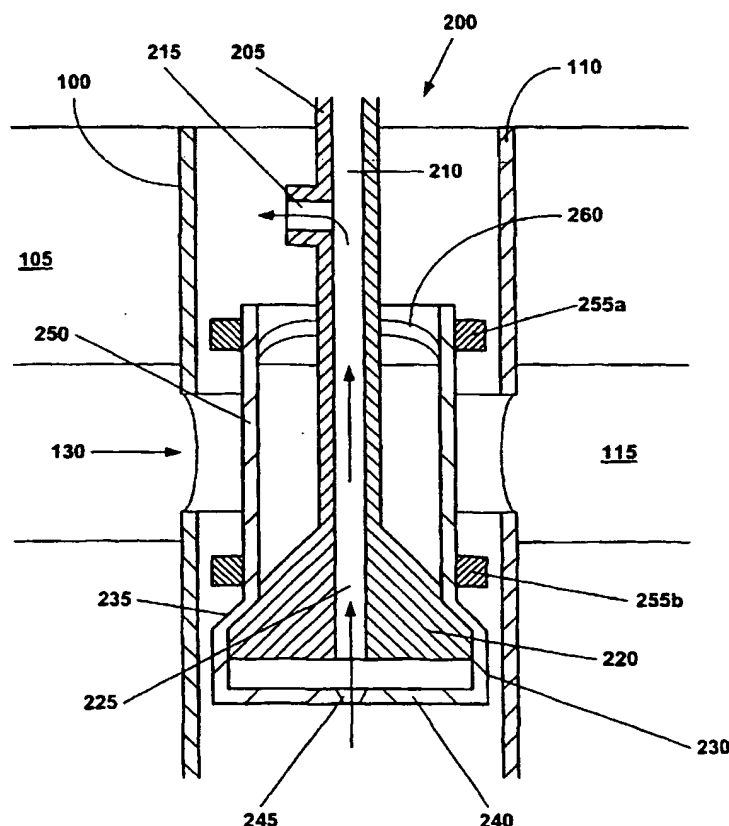
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(72) Inventors; and

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[Continued on next page]

(54) Title: LINER HANGER WITH SLIP JOINT SEALING MEMBERS AND METHOD OF USE



(57) Abstract: An apparatus (200) and method for repairing an opening (130) in a wellbore casing (110). The apparatus (200) and method couple a floating tubular (250) member in opposing relation to the opening (130) in the wellbore casing (110).

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

LINER HANGER WITH SLIP JOINT  
SEALING MEMBERS

Cross Reference To Related Applications

5        This application claims the benefit of the filing date of U.S. provisional patent application serial number 60/221,443, attorney docket number 25791.45, filed on 7/28/2000, the disclosure of which is incorporated herein by reference.

      This application is related to the following co-pending applications:  
      (1) U.S. patent application serial no. 09/440,338, attorney docket number 25791.9.02, filed on 11/15/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/108,558, attorney  
10        docket number 25791.9, filed on 11/16/1998, (2) U.S. patent application serial no. 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/111,293, filed on 12/7/1998, (3) U.S. patent application serial number 09/502,350, attorney docket number  
15        25791.8.02, filed on 2/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/119,611, attorney docket number 25791.8, filed on 2/11/1999, (4) U.S. patent application serial number 09/510,913, attorney docket number 25791.7.02, filed on 2/23/2000, which claimed the benefit of the filing date of U.S. provisional  
20        patent application serial number 60/121,702, attorney docket number 25791.7, filed on 2/25/1999, (5) U.S. patent application serial number 09/511,941, attorney docket number 25791.16.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application number 60/121,907, attorney docket number 25791.16, filed on  
25        2/26/1999, (6) U.S. patent application serial number 09/523,460, attorney docket number 25791.11.02, filed on 3/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/124,042, attorney docket number 25791.11, filed on 3/11/1999, (7) U.S. patent application serial number 09/559,122, attorney docket number

25791.23.02, filed on 4/26/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/131,106, attorney docket number 25791.23, filed on 4/26/1999, (8) U.S. patent application serial number \_\_\_\_\_, attorney docket number 25791.17.02, filed on \_\_\_\_\_, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/137,998, attorney docket number 25791.17, filed on 6/7/1999, (9) U.S. provisional patent application serial number 60/143,039, attorney docket number 25791.26, filed on 7/9/1999, (10) U.S. provisional patent application serial number 60/146,203, attorney docket number 25791.25, filed on 7/29/1999, the disclosures of which are incorporated by reference; (11) U.S. provisional patent application serial number 60/183,546, attorney docket number 25791.10, filed on 2/18/2000; (12) U.S. patent application serial number 09/512,895, attorney docket number 25791.12.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,841, attorney docket number 25791.12, filed on 2/26/1999; (13) U.S. provisional patent application serial number \_\_\_\_\_, attorney docket number 25791.38, filed on 6/19/2000; (14) U.S. provisional patent application serial number 60/162,671, attorney docket number 25791.27, filed on 11/1/1999; (15) U.S. provisional patent application serial number 60/159,039, attorney docket number 25791.36, filed on 10/12/1999; (16) U.S. provisional patent application serial number 60/159,033, attorney docket number 25791.37, filed on 10/12/1999; (17) U.S. provisional patent application serial number 60/165,228, attorney docket number 25791.39, filed on 11/12/1999; and (18) U.S. provisional patent application serial number \_\_\_\_\_, attorney docket number 25791.46, filed on \_\_\_\_\_, the disclosures of which are incorporated herein by reference.

#### Background of the Invention

This invention relates generally to wellbore casings, and in particular to apparatus and methods for repairing wellbore casings.

Conventionally, when a wellbore casing is damaged, a tubular liner is positioned within the damaged section of the wellbore casing in order to provide structural support and prevent the undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. However, conventional tubular liners used for repairing damaged sections of wellbore casings suffer from a number of serious drawback. For example, conventional tubular liners used for repairing damaged sections of wellbore casings are not designed to accommodate variable loading conditions.

The present invention is directed to overcoming one or more of the limitations of the existing apparatus and methods for repairing damaged sections of wellbore casings.

#### Summary of the Invention

According to one aspect of the present invention, a method of repairing a damaged section of a wellbore casing is provided that includes removing at least a portion of the damaged section of the wellbore casing to create an opening in the wellbore casing, and covering at least a portion of the opening in the wellbore casing with a floating tubular member.

According to another aspect of the present invention, a radially expandable tubular member for repairing an opening in a wellbore casing is provided that includes a tubular member and a slip joint coupled to the exterior surface of the tubular member.

According to another aspect of the present invention, an apparatus for repairing an opening in a wellbore casing is provided that includes a tubular support member including a first passage, an expansion cone coupled to the tubular support member including a second passage fluidically coupled to the first passage, an expansion cone launcher coupled to the expansion cone including a shoe having an exhaust passage, and an expandable tubular member coupled to the expansion cone launcher including one or more sealing members having slip joints.

According to another aspect of the present invention, an apparatus is provided that includes a wellbore casing including an opening, and a floating tubular member coupled to the wellbore casing in opposing relation to the opening.

5        According to another aspect of the present invention, a system for repairing a damaged section of a wellbore casing is provided that includes means for removing at least a portion of the damaged section of the wellbore casing to create an opening in the wellbore casing, and means for covering at least a portion of the opening in the wellbore casing with a  
10       floating tubular member.

#### Brief Description of the Drawings

FIG. 1 is a cross-sectional view illustrating a wellbore casing including a damaged section.

15       FIG. 2 is a fragmentary cross-sectional view illustrating the introduction of a milling device into the wellbore casing of FIG. 1.

FIG. 3 is a fragmentary cross-sectional view illustrating the removal of at least a portion of the damaged section of the wellbore casing using the milling device to form an opening in the wellbore casing of FIG. 2.

20       FIG. 4 is a fragmentary cross-sectional view illustrating the placement of a repair apparatus for covering the opening in the wellbore casing of FIG. 3.

FIG. 5 is a fragmentary cross-sectional view illustrating the injection of fluidic materials into the repair apparatus of FIG. 4.

25       FIG. 6 is a fragmentary cross-sectional view illustrating the pressurization of the interior of the repair apparatus of FIG. 5.

FIG. 7 is a fragmentary cross-sectional view illustrating the completion of the radial expansion of the expandable tubular member of the repair apparatus of FIG. 6.

30       FIG. 8 is a cross-sectional view illustrating the milling out of the shoe of the radially expanded tubular member of FIG. 7.

FIG. 9 is a cross-sectional illustration of an embodiment of upper and lower sealing members that include internal slip joints.

#### Detailed Description of the Illustrative Embodiments

5 An apparatus and method for repairing an opening in a damaged section of a wellbore casing within a subterranean formation is provided. The apparatus and method provides a system for repairing an opening in a damaged section of a wellbore casing within a subterranean formation in which a tubular member is radially expanded into contact with the wellbore casing. The physical connection between the radially expanded  
10 tubular member and the wellbore casing is preferably compliant and permits movement of the radially expanded tubular member relative to the wellbore casing in at least the longitudinal direction. In this manner, the radially expanded tubular member is capable of absorbing a wide range of loading conditions.

15 Referring initially to Fig. 1, a wellbore 100 positioned within a subterranean formation 105 includes a preexisting casing 110 that traverses a producing formation 115. The portion of the casing 110 that traverses the producing formation 115 includes a damaged section 120. As will be recognized by persons having ordinary skill in the art, the  
20 damaged section 120 may be caused by, for example, structural instabilities in the producing formation 115 such as, for example, subsidence that can cause buckling of the wellbore casing 110.

Referring to Figs. 2 and 3, in order to repair the damaged section 120 of the wellbore casing 110, a conventional milling device 125 is then  
25 inserted into the wellbore casing 110. The milling device 125 is then used to remove at least a portion of the damaged section 120 of the wellbore casing 110 and thereby form an opening 130 in the wellbore casing 110.

Referring to Fig. 4, an apparatus 200 for repairing the opening 130 in the wellbore casing 110 may then be positioned within the wellbore  
30 casing proximate the opening in the wellbore casing.

The apparatus 200 includes a tubular support member 205 having a longitudinal passage 210 and a transverse passage 215 that is coupled to an expansion cone 220 having a longitudinal passage 225 that is fluidically coupled to the longitudinal passage 210. The expansion cone 220 is at least partially received within an expansion cone launcher 230 that includes a thin-walled annular member 235 and a shoe 240 having an exhaust passage 245. An expandable tubular member 250 extends from the expansion cone launcher 230 that includes upper and lower sealing members 255a and 255b affixed to the exterior surface of the expandable tubular member. A sealing cup 260 is attached to the exterior surface of the tubular support member 205 for preventing foreign materials from entering the interior of the expandable tubular member 250.

In a preferred embodiment, the apparatus 200 is provided as disclosed in one or more of the following: (1) U.S. patent application serial no. 09/440,338, attorney docket number 25791.9.02, filed on 11/15/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/108,558, attorney docket number 25791.9, filed on 11/16/1998, (2) U.S. patent application serial no. 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/111,293, filed on 12/7/1998, (3) U.S. patent application serial number 09/502,350, attorney docket number 25791.8.02, filed on 2/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/119,611, attorney docket number 25791.8, filed on 2/11/1999, (4) U.S. patent application serial number 09/510,913, attorney docket number 25791.7.02, filed on 2/23/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,702, attorney docket number 25791.7, filed on 2/25/1999, (5) U.S. patent application serial number 09/511,941, attorney docket number 25791.16.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application number

60/121,907, attorney docket number 25791.16, filed on 2/26/1999, (6) U.S. patent application serial number 09/523,460, attorney docket number 25791.11.02, filed on 3/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/124,042, attorney docket number 25791.11, filed on 3/11/1999, (7) U.S. patent application serial number 09/559,122, attorney docket number 25791.23.02, filed on 4/26/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/131,106, attorney docket number 25791.23, filed on 4/26/1999, (8) U.S. patent application serial number \_\_\_\_\_, attorney docket number 25791.17.02, filed on \_\_\_\_\_, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/137,998, attorney docket number 25791.17, filed on 6/7/1999, (9) U.S. provisional patent application serial number 60/143,039, attorney docket number 25791.26, filed on 7/9/1999, (10) U.S. provisional patent application serial number 60/146,203, attorney docket number 25791.25, filed on 7/29/1999, the disclosures of which are incorporated by reference; (11) U.S. provisional patent application serial number 60/183,546, attorney docket number 25791.10, filed on 2/18/2000; (12) U.S. patent application serial number 09/512,895, attorney docket number 25791.12.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,841, attorney docket number 25791.12, filed on 2/26/1999; (13) U.S. provisional patent application serial number \_\_\_\_\_, attorney docket number 25791.38, filed on 6/19/2000; (14) U.S. provisional patent application serial number 60/162,671, attorney docket number 25791.27, filed on 11/1/1999; (15) U.S. provisional patent application serial number 60/159,039, attorney docket number 25791.36, filed on 10/12/1999; (16) U.S. provisional patent application serial number 60/159,033, attorney docket number 25791.37, filed on 10/12/1999; and (17) U.S. provisional patent application serial



number 60/165,228, attorney docket number 25791.39, filed on 11/12/1999, the disclosures of which are incorporated herein by reference.

As illustrated in Fig. 4, during placement of the apparatus 200 within the wellbore casing 110, fluidic materials displaced by the apparatus 200 are conveyed through the longitudinal passages 210 and 225 to the transverse passage 215. In this manner, surge pressures during the placement of the apparatus 200 within the wellbore casing 110 are minimized. Furthermore, as illustrated in Fig. 4, the apparatus 200 is preferably positioned with the tubular member 250 in opposing relation to the opening 130 in the wellbore casing 110. In this manner, the upper and lower sealing members 255a and 255b may engage portions of the wellbore casing 110 above and below the opening 130 after radially expanding the tubular member 250.

As illustrated in Fig. 5, the transverse passage 215 may then be closed and fluidic materials injected into the apparatus 200 through the longitudinal passage 210. In this manner, any blockages within any of the passages 210, 225, and 245 may be detected by monitoring the operating pressure whereby an increase in operating pressure above nominal, or predetermined, conditions may indicate a blockage of one of the passages.

As illustrated in Fig. 6, a plug 265 or other conventional stop member may then be introduced into the fluidic materials injected into the apparatus 200 through the passage 210, and the plug 265 may be positioned within the passage 245. In this manner, the passage 245 may be sealed off. Thus, continued injection of fluidic materials into the apparatus 200 through the passage 210 may thereby pressurize a region 270 below the expansion cone 220.

As illustrated in Fig. 7, continued pressurization of the region 270 causes the expansion cone 220 to radially expand the expandable tubular member 250 off of the expansion cone. In this manner, the upper and lower sealing members 255a and 255b preferably engage the interior walls of the wellbore casing 110 above and below the opening 130 thereby

sealing off the opening. In a preferred embodiment, during the radial expansion process, the tubular support member 205 is raised out of the wellbore 100.

5 As illustrated in Fig. 8, the shoe 240 may then be removed using a conventional milling device. In this manner, exploration and production of subterranean regions beyond the opening 130 in the wellbore casing 110 may be conducted.

10 In several alternative embodiments, the upper sealing member 255a or the lower sealing member 255b are omitted from the tubular member 250. In this manner, the radially expanded tubular member 250 is permitted to float relative to the wellbore casing 110. Furthermore, in this manner, relative longitudinal and/or transverse movements of the sections of the wellbore casing 110 above and below the opening 130 may be optimally accommodated by the radially expanded tubular member 15 250. Finally, in this manner, damage to the radially expanded tubular member 250 that can be caused by longitudinal stresses, such as buckling, may be minimized or eliminated.

20 In another alternative embodiment, as illustrated in Fig. 9, the upper sealing member 255a and/or the lower sealing member 255b include internal slip joints 300a and 300b in order to permit the radially expanded tubular member 250 to float relative to the wellbore casing 110. In this manner, relative longitudinal and/or transverse movements of the sections of the wellbore casing 110 above and below the opening 130 may be optimally accommodated. Furthermore, in this manner, damage to the 25 radially expanded tubular member 250 that can be caused by longitudinal stresses, such as buckling, may be minimized or eliminated.

30 In a preferred embodiment, the sealing members 255a and 255b permit the radially expanded tubular member 250 to move in the longitudinal direction while also maintaining a fluidic seal. In several alternative embodiments, the sealing members 255a and 255b are

fabricated from a resilient material such as, for example, synthetic or natural rubber.

5 It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the apparatus 200 may be used to repair, for example, a wellbore casing, a pipeline, or a structural support.

10 Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

## Claims

What is claimed is:

- 1     1.     A method of repairing a damaged section of a wellbore casing,  
2     comprising:  
3         removing at least a portion of the damaged section of the wellbore  
4         casing to create an opening in the wellbore casing; and  
5         covering at least a portion of the opening in the wellbore casing  
6         with a floating tubular member.
- 1     2.     The method of claim 1, further comprising:  
2         coupling the tubular member to the wellbore casing with a slip  
3         joint.
- 1     3.     The method of claim 1, wherein covering at least a portion of the  
2     opening in the wellbore casing with a floating tubular member comprises:  
3         radially expanding at least a portion of the tubular member into  
4         contact with the wellbore casing.
- 1     4.     The method of claim 3, wherein the radially expanded tubular  
2     member contacts the wellbore casing above and below the opening.
- 1     5.     The method of claim 3, wherein the radially expanded tubular  
2     member only contacts the wellbore casing above the opening.
- 1     6.     The method of claim 3, wherein the radially expanded tubular  
2     member only contacts the wellbore casing below the opening.
- 1     7.     A radially expandable tubular member for repairing an opening in  
2     a wellbore casing, comprising:

3 a tubular member; and  
4 a slip joint coupled to the exterior surface of the tubular member.

1 8. An apparatus for repairing an opening in a wellbore casing,  
2 comprising:  
3 a tubular support member comprising a first passage;  
4 an expansion cone coupled to the tubular support member  
5 comprising a second passage fluidically coupled to the first  
6 passage;  
7 an expansion cone launcher coupled to the expansion cone  
8 comprising a shoe having an exhaust passage; and  
9 an expandable tubular member coupled to the expansion cone  
10 launcher comprising one or more sealing members having  
11 slip joints.

1 9. An apparatus, comprising:  
2 a wellbore casing comprising an opening; and  
3 a floating tubular member coupled to the wellbore casing in  
4 opposing relation to the opening.

1 10. A system for repairing a damaged section of a wellbore casing,  
2 comprising:  
3 means for removing at least a portion of the damaged section of the  
4 wellbore casing to create an opening in the wellbore casing;  
5 and  
6 means for covering at least a portion of the opening in the wellbore  
7 casing with a floating tubular member.

1 11. The system of claim 10, further comprising:  
2 means for coupling the tubular member to the wellbore casing with  
3 a slip joint.

1     12.   The system of claim 10, wherein the means for covering at least a  
2     portion of the opening in the wellbore casing with a floating tubular  
3     member comprises:

4             means for radially expanding at least a portion of the tubular  
5             member into contact with the wellbore casing.

1     13.   The system of claim 12, wherein the means for radially expanded  
2     tubular member comprises:

3             means for radially expanding the tubular member into contact with  
4             the wellbore casing above and below the opening.

1     14.   The system of claim 12, wherein the radially expanded tubular  
2     member only contacts the wellbore casing above the opening.

1     15.   The system of claim 12, wherein the radially expanded tubular  
2     member only contacts the wellbore casing below the opening.

**AMENDED CLAIMS**

[received by the International Bureau on 28 December 2001 (21.12.01);  
new claims 16-45 added; remaining claims unchanged (5 pages)]

- 1     12.     The system of claim 10, wherein the means for covering at least a  
2     portion of the opening in the wellbore casing with a floating tubular  
3     member comprises:  
4             means for radially expanding at least a portion of the tubular  
5             member into contact with the wellbore casing.
- 1     13.     The system of claim 12, wherein the means for radially expanded  
2     tubular member comprises:  
3             means for radially expanding the tubular member into contact with  
4             the wellbore casing above and below the opening.
- 1     14.     The system of claim 12, wherein the radially expanded tubular  
2     member only contacts the wellbore casing above the opening.
- 1     15.     The system of claim 12, wherein the radially expanded tubular  
2     member only contacts the wellbore casing below the opening.
- 1     16.     A method of repairing a damaged section of a pipeline, comprising:  
2             removing at least a portion of the damaged section of the pipeline to  
3             create an opening in the pipeline; and  
4             covering at least a portion of the opening in the pipeline with a  
5             floating tubular member.
- 1     17.     The method of claim 16, further comprising:  
2             coupling the tubular member to the pipeline with a slip joint.
- 1     18.     The method of claim 16, wherein covering at least a portion of the  
2     opening in the pipeline with a floating tubular member comprises:  
3             radially expanding at least a portion of the tubular member into  
4             contact with the pipeline.
- 1     19.     The method of claim 18, wherein the radially expanded tubular  
2     member contacts the pipeline above and below the opening.

- 1     20.     The method of claim 18, wherein the radially expanded tubular  
2     member only contacts the pipeline above the opening.
- 1     21.     The method of claim 18, wherein the radially expanded tubular  
2     member only contacts the pipeline below the opening.
- 1     22.     A radially expandable tubular member for repairing an opening in a  
2     pipeline, comprising:  
3             a tubular member; and  
4             a slip joint coupled to the exterior surface of the tubular member.
- 1     23.     An apparatus for repairing an opening in a pipeline, comprising:  
2             a tubular support member comprising a first passage;  
3             an expansion cone coupled to the tubular support member  
4                 comprising a second passage fluidically coupled to the first  
5                 passage;  
6             an expansion cone launcher coupled to the expansion cone  
7                 comprising a shoe having an exhaust passage; and  
8             an expandable tubular member coupled to the expansion cone  
9                 launcher comprising one or more sealing members having slip  
10             joints.
- 1     24.     An apparatus, comprising:  
2             a pipeline comprising an opening; and  
3             a floating tubular member coupled to the pipeline in opposing  
4             relation to the opening.
- 1     25.     A system for repairing a damaged section of a pipeline, comprising:  
2             means for removing at least a portion of the damaged section of the  
3             pipeline to create an opening in the pipeline; and  
4             means for covering at least a portion of the opening in the pipeline  
5             with a floating tubular member.



- 1     26.    The system of claim 25, further comprising:  
2            means for coupling the tubular member to the pipeline with a slip  
3            joint.
- 1     27.    The system of claim 25, wherein the means for covering at least a  
2            portion of the opening in the pipeline with a floating tubular member  
3            comprises:  
4            means for radially expanding at least a portion of the tubular  
5            member into contact with the pipeline.
- 1     28.    The system of claim 27, wherein the means for radially expanded  
2            tubular member comprises:  
3            means for radially expanding the tubular member into contact with  
4            the pipeline above and below the opening.
- 1     29.    The system of claim 27, wherein the radially expanded tubular  
2            member only contacts the pipeline above the opening.
- 1     30.    The system of claim 27, wherein the radially expanded tubular  
2            member only contacts the pipeline below the opening.
- 1     31.    A method of repairing a damaged section of a structural support,  
2            comprising:  
3            removing at least a portion of the damaged section of the structural  
4            support to create an opening in the structural support; and  
5            covering at least a portion of the opening in the structural support  
6            with a floating tubular member.
- 1     32.    The method of claim 31, further comprising:  
2            coupling the tubular member to the structural support with a slip  
3            joint.

1 33. The method of claim 31, wherein covering at least a portion of the  
2 opening in the structural support with a floating tubular member comprises:  
3 radially expanding at least a portion of the tubular member into  
4 contact with the structural support.

1 34. The method of claim 33, wherein the radially expanded tubular  
2 member contacts the structural support above and below the opening.

1 35. The method of claim 33, wherein the radially expanded tubular  
2 member only contacts the structural support above the opening.

1 36. The method of claim 33, wherein the radially expanded tubular  
2 member only contacts the structural support below the opening.

1 37. A radially expandable tubular member for repairing an opening in a  
2 structural support, comprising:  
3 a tubular member; and  
4 a slip joint coupled to the exterior surface of the tubular member.

1 38. An apparatus for repairing an opening in a structural support,  
2 comprising:  
3 a tubular support member comprising a first passage;  
4 an expansion cone coupled to the tubular support member  
5 comprising a second passage fluidically coupled to the first  
6 passage;  
7 an expansion cone launcher coupled to the expansion cone  
8 comprising a shoe having an exhaust passage; and  
9 an expandable tubular member coupled to the expansion cone  
10 launcher comprising one or more sealing members having slip  
11 joints.

1 39. An apparatus, comprising:  
2 a structural support comprising an opening; and

3 a floating tubular member coupled to the structural support in  
4 opposing relation to the opening.

1 40. A system for repairing a damaged section of a structural support,  
2 comprising:  
3 means for removing at least a portion of the damaged section of the  
4 structural support to create an opening in the structural  
5 support; and  
6 means for covering at least a portion of the opening in the structural  
7 support with a floating tubular member.

1 41. The system of claim 40, further comprising:  
2 means for coupling the tubular member to the structural support  
3 with a slip joint.

1 42. The system of claim 40, wherein the means for covering at least a  
2 portion of the opening in the structural support with a floating tubular  
3 member comprises:  
4 means for radially expanding at least a portion of the tubular  
5 member into contact with the structural support.

1 43. The system of claim 42, wherein the means for radially expanded  
2 tubular member comprises:  
3 means for radially expanding the tubular member into contact with  
4 the structural support above and below the opening.

1 44. The system of claim 42, wherein the radially expanded tubular  
2 member only contacts the structural support above the opening.

1 45. The system of claim 42, wherein the radially expanded tubular  
2 member only contacts the structural support below the opening.

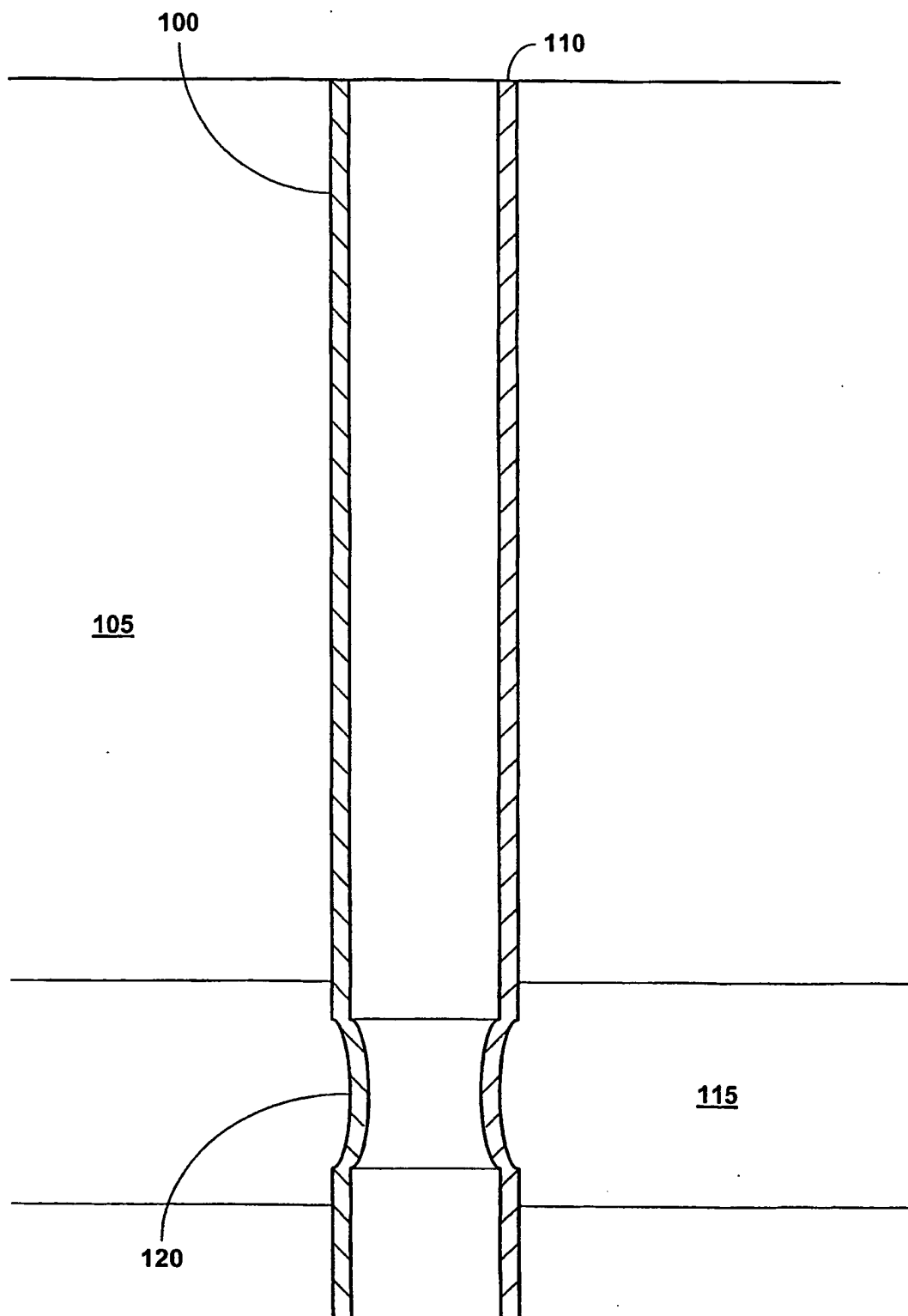


FIGURE 1

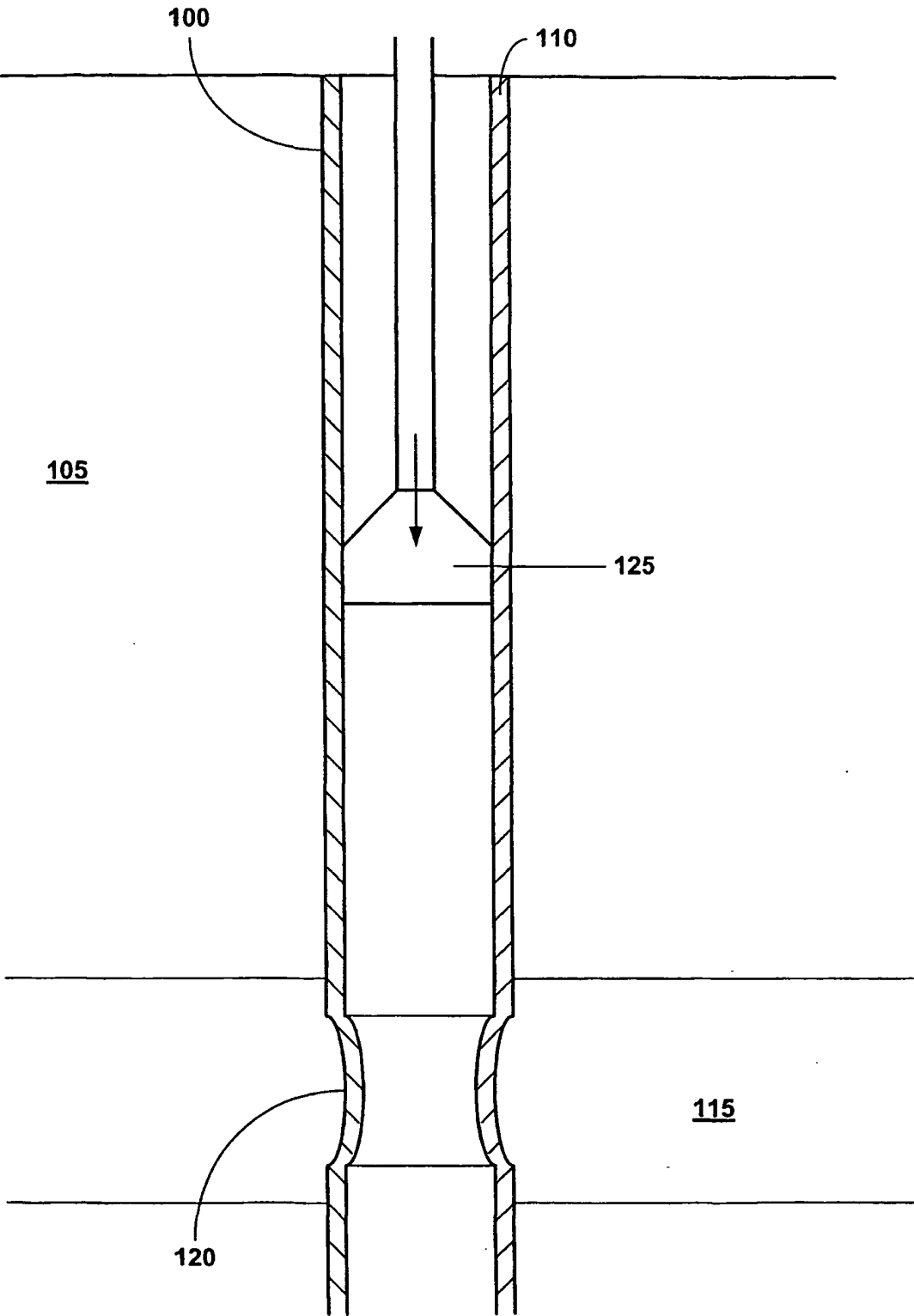


FIGURE 2

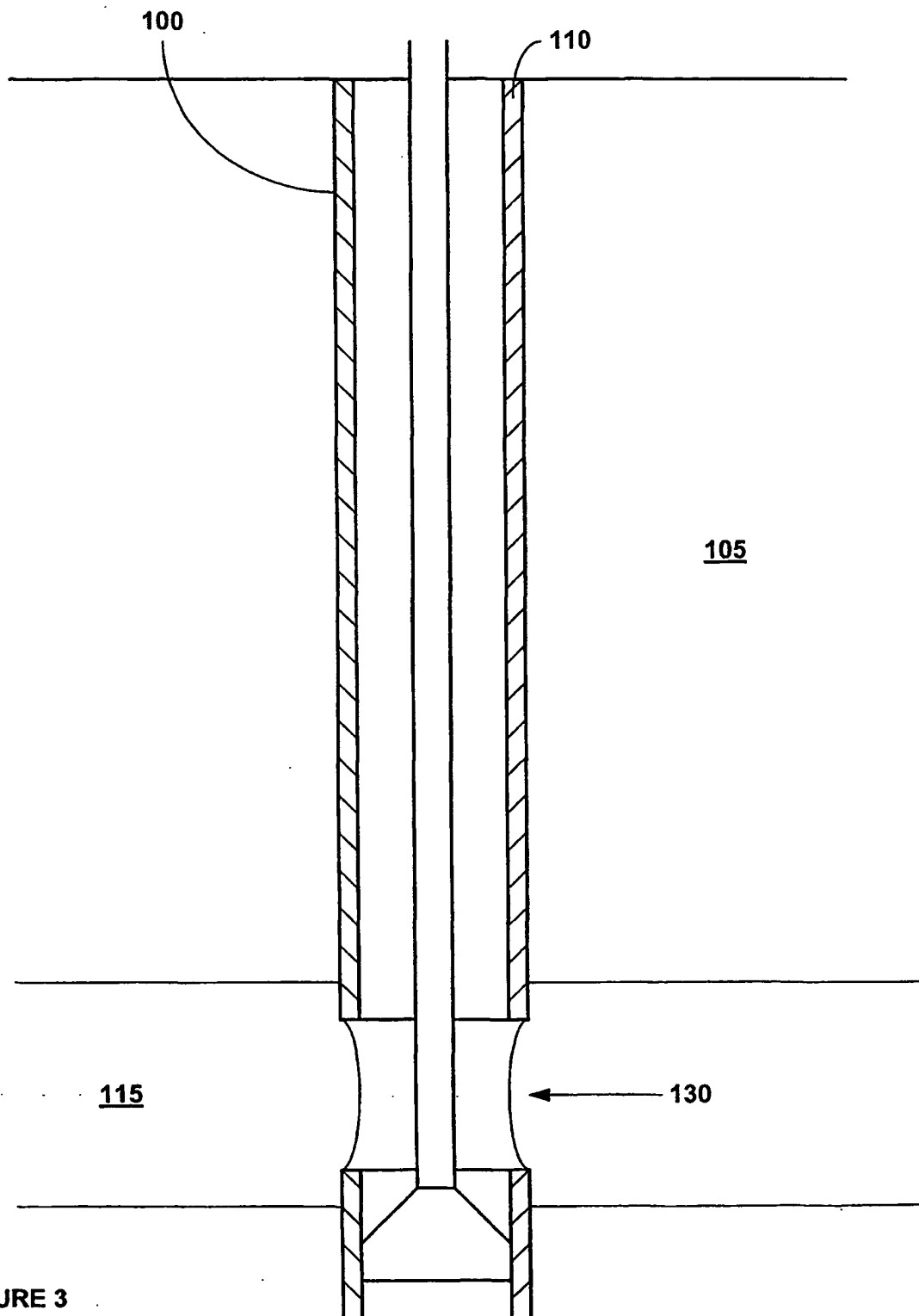


FIGURE 3

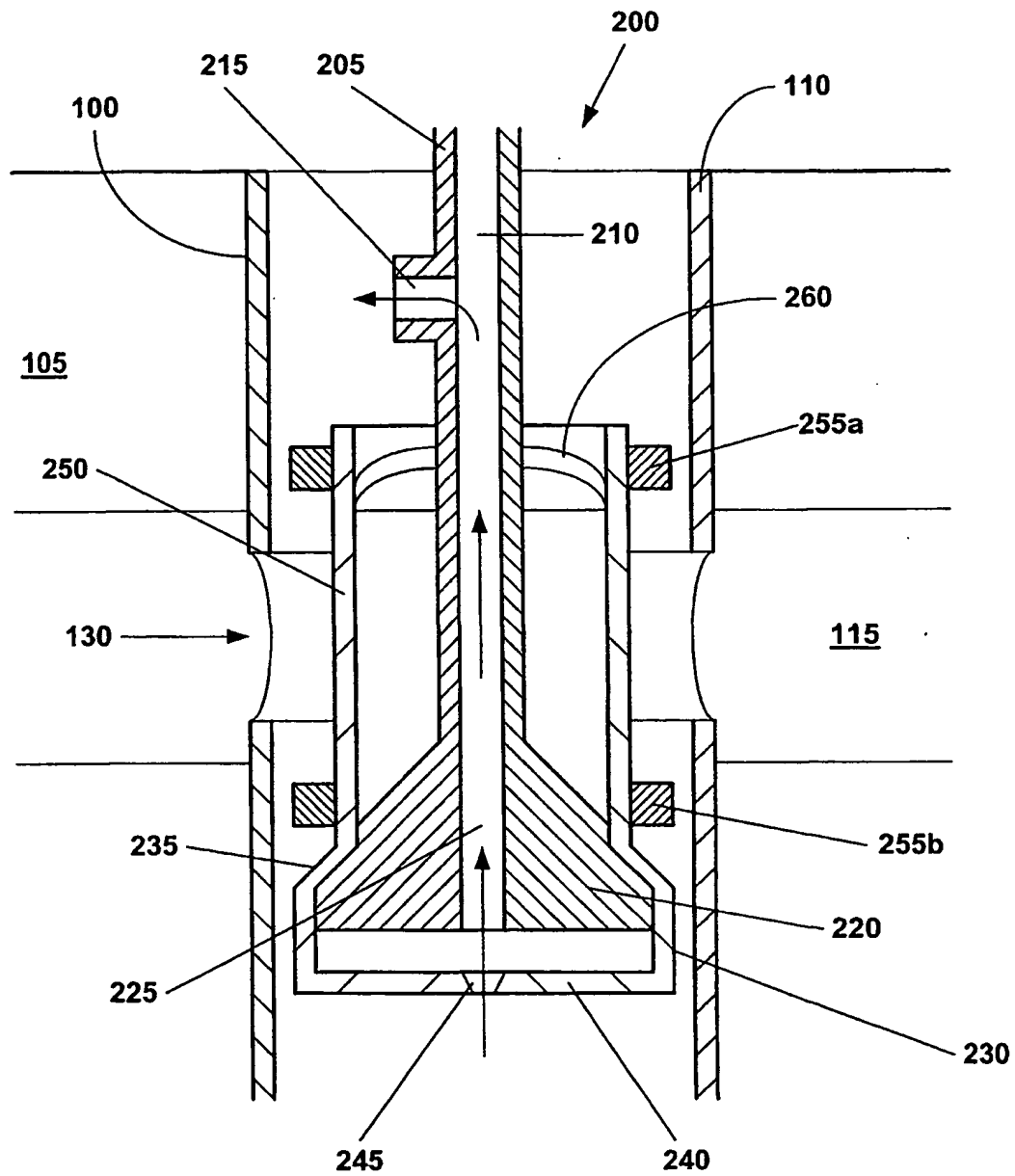


FIGURE 4

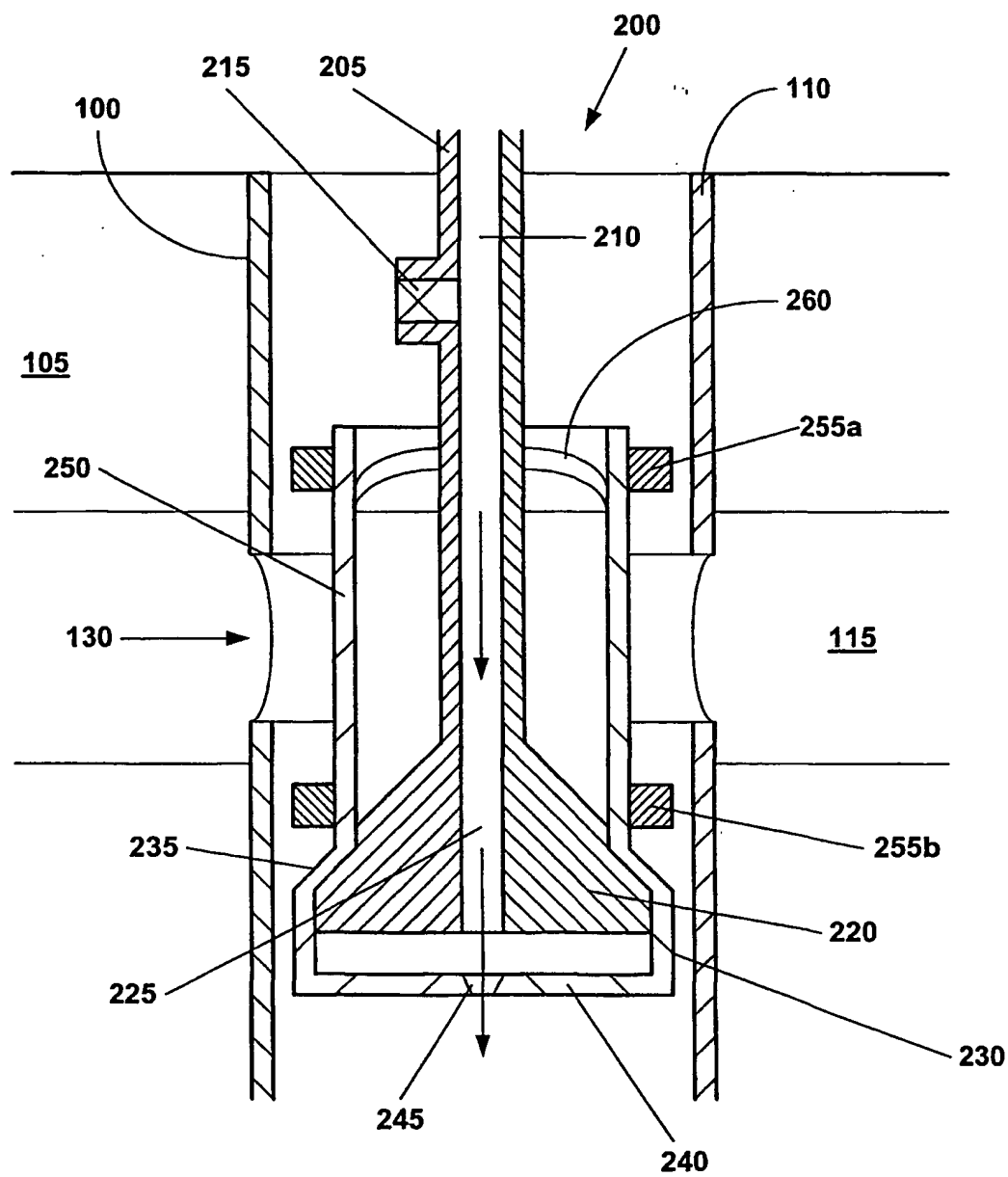


FIGURE 5



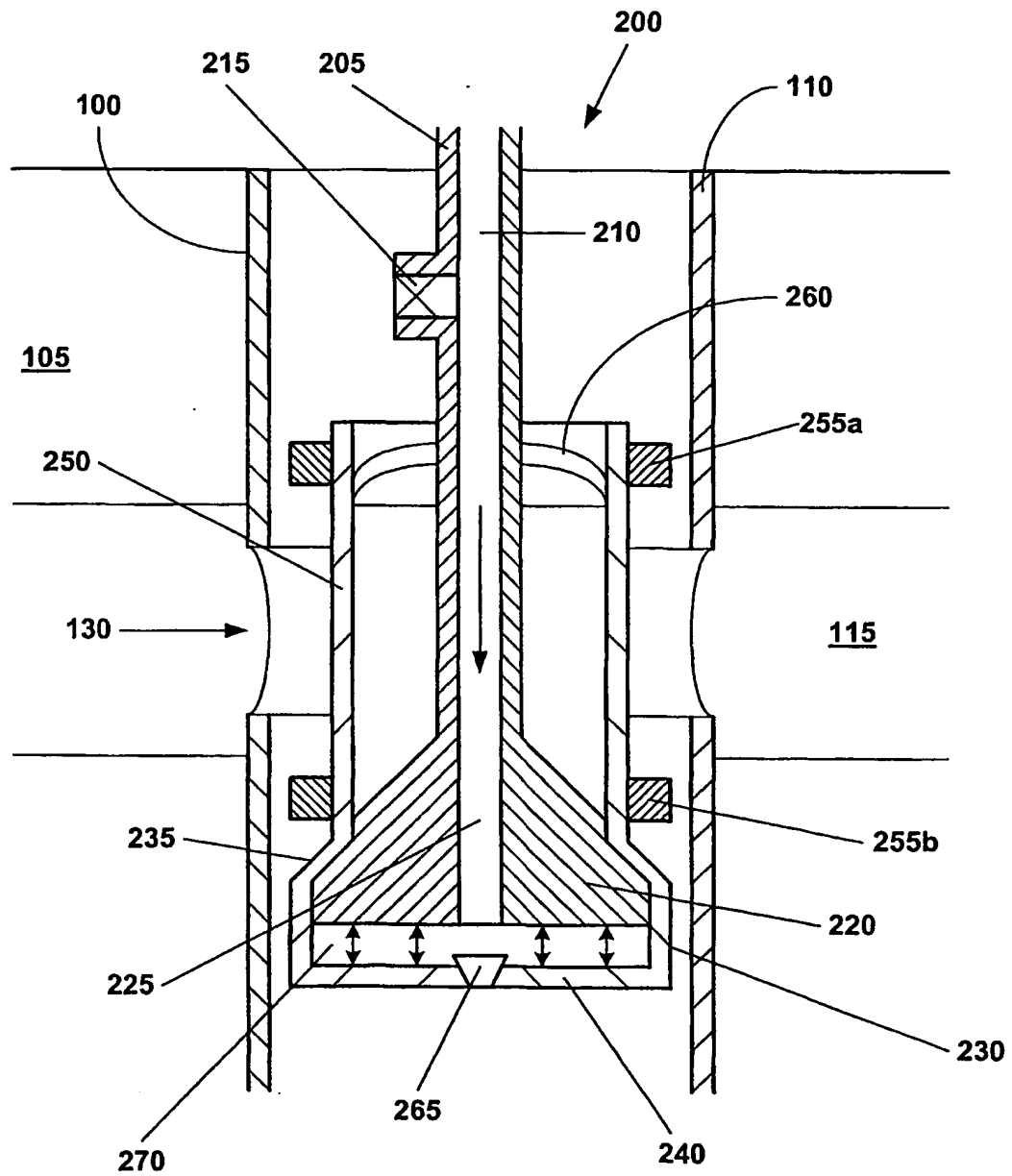


FIGURE 6

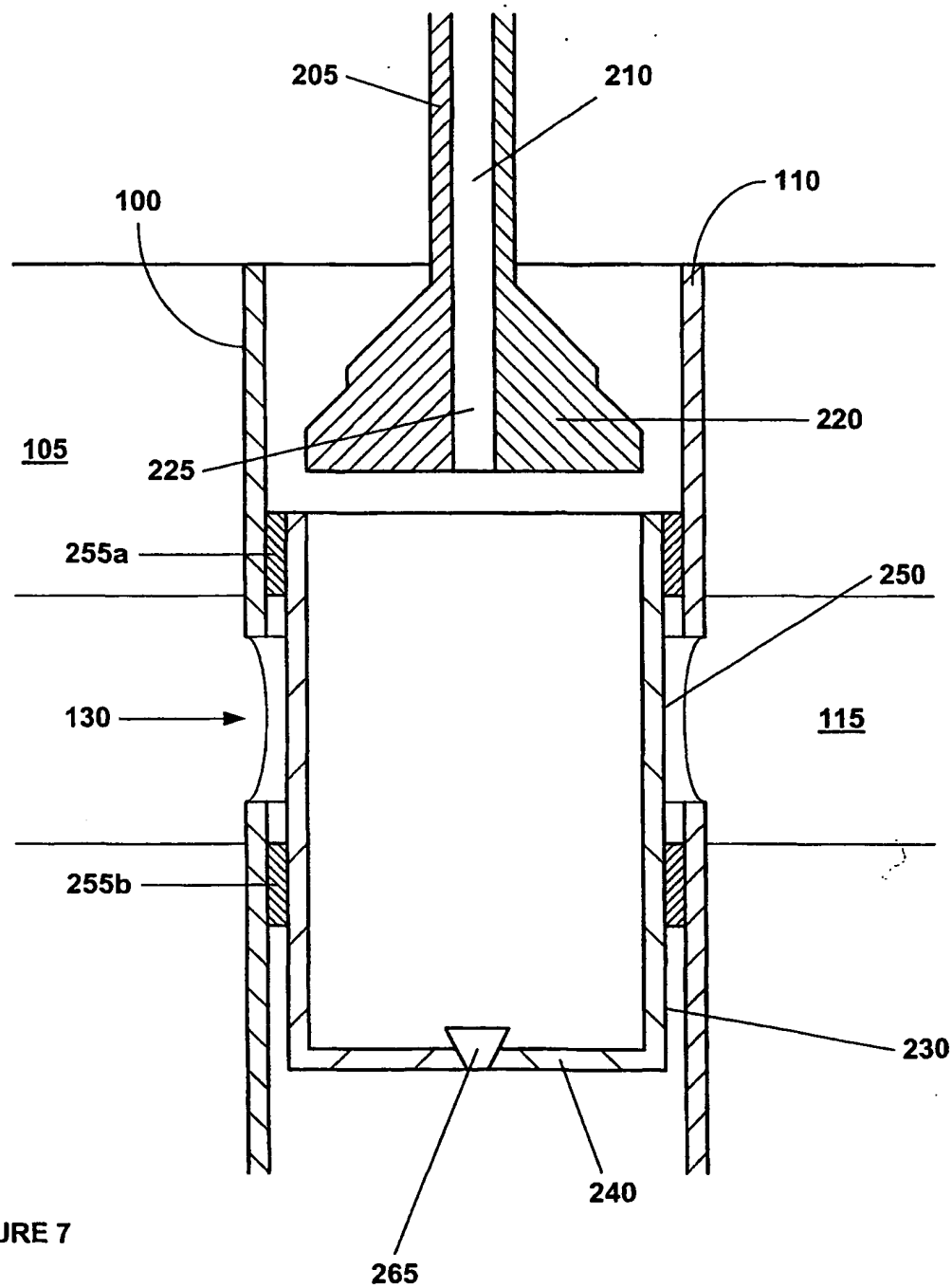


FIGURE 7

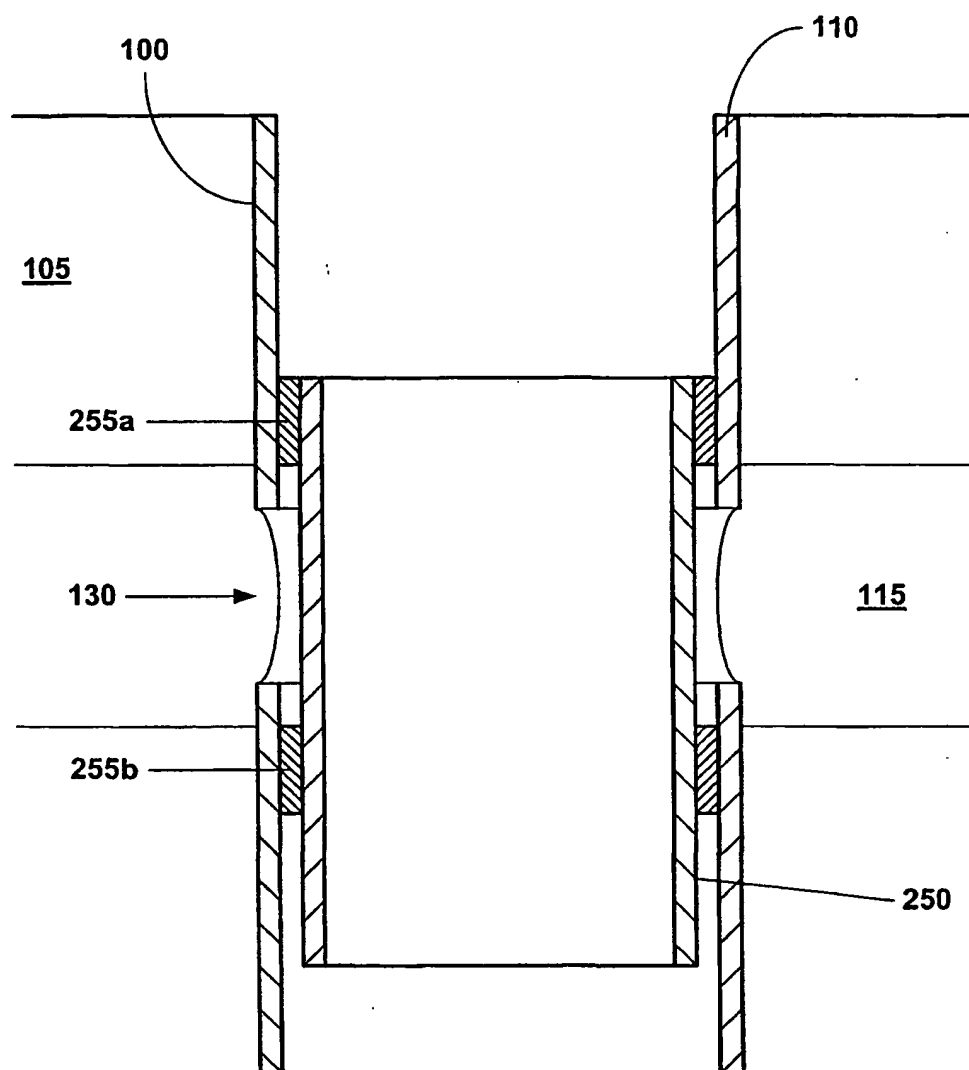


FIGURE 8

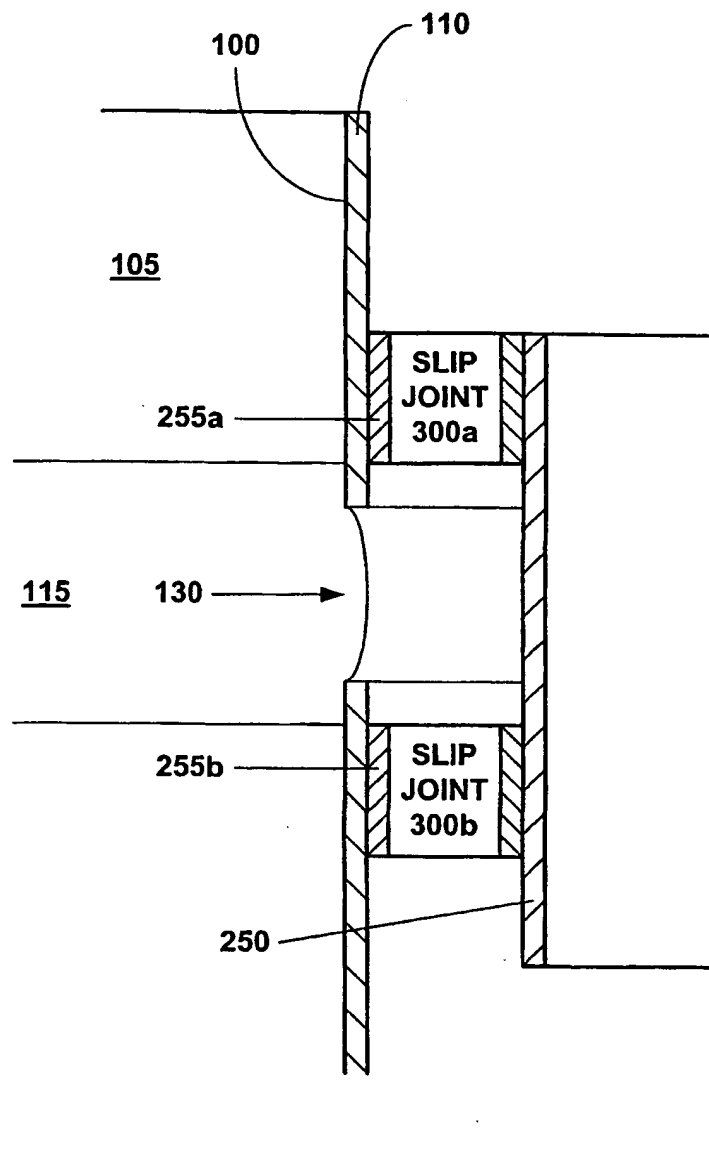


FIGURE 9

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/41446

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E21B 29/10, 43/10

US CL : 166/206, 277

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 166/206, 277, 297, 384, 55, 207, 217, 212, 387

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
Please See Continuation Sheet

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, P	US 6,142,230 A (Smalley et al.) 07 November 2000 (07.11.2000), column 13, lines 1-45.	1-15
A, P	US 6,263,968 B1 (Freeman et al.) 24 July 2001 (24.07.2001), see Abstract.	1-15
A	US 5,507,343 A (Carlton et al.) 16 April 1996 (16.04.1996), see Abstract.	1-15
A	US 5,083,608 A (Abdrakmanov et al.) 28 January 1992 (28.01.1992), see Abstract.	1-15
A	US 5,833,001 A (Song et al.) 10 November 1998 (10.11.1998), see Abstract.	1-15
A	US 3,326,293 A (Skipper) 20 June 1967 (20.06.1967), see Abstract.	1-15
A	US 6,070,671 A (Cumming et al.) 06 June 2000 (06.06.2000), see Abstract.	1-15
A, E	US 6,283,211 B1 (Vloedman) 04 September 2001 (04.09.2001), see Abstract	1-15
A	US 3,489,220 A (Kinley) 13 January 1970 (13.01.1970), see Abstract.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason is specified	"Y"	document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search

13 September 2001 (13.09.2001)

Date of mailing of the international search report

30 OCT 2001

Name and mailing address of the ISA/US

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/41446

## C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,785,120 A (Smalley et al.) 28 July 1998 (28.07.1998), see Abstract.	1-15
A	US 4,660,863 A (Bailey et al.) 28 April 1987 (28.04.1987), see Abstract.	1-15

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/41446

## Continuation of B. FIELDS SEARCHED Item 3:

EAST

search terms: expandable (casing tubing liner), expanding (casing tubing liner), slip joint, floating (tube tubular tubing patch liner casing), opening, window